CENTRE FOR EVIDENCE-BASED CONSERVATION

SYSTEMATIC REVIEW No. 22

THE EFFECTIVENESS OF MANAGEMENT OPTIONS USED FOR THE CONTROL OF SPARTINA SPECIES

REVIEW REPORT

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Roberts, P.D. and Pullin, A.S. (2006) The Effectiveness of Management Options Used for the Control of Spartina Species. Systematic Review No. 22. Centre for Evidence-Based Conservation, Birmingham, UK.

COVER SHEET

Title	**The Effectiveness of Management Options Used for the Control of Spartina Species**
Systematic review	**N$^{o.}$ 22**
Reviewer(s)	Roberts, P.D. (PDR) & Pullin, A.S (ASP)
Date draft protocol published on website	9 May 2006
Date final protocol first published on website	23 June 2006
Date draft review first published on website	15 September 2006
Date final review published on website	27 November 2006
Date of most recent amendment	-
Date of most recent SUBSTANTIVE amendment	-
Details of most recent changes	-
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Sources of support	NERC PhD stipend incl. English Nature CASE award.
Conflict of interests	None reported.

SYSTEMATIC REVIEW SUMMARY

Background

Spartina spp. (cordgrasses) have been introduced to the estuaries around Europe, U.S.A., Australia, New Zealand and Asia as a coastal management tool to stabilise mud banks and through accidental introductions. These non-native *Spartina* species are highly aggressive in their new environment, and frequently become the dominant plant species in areas they invade displacing native flora and fauna. Over the past decade coastal management priorities have changed, with control of non-native species becoming important.

Objective

To investigate the effectiveness of management interventions used to control the abundance or completely eradicate invasive *Spartina* species and to analyse, when possible, the effects that potential sources of heterogeneity (e.g. substrate type) have on the results

Search Strategy

Electronic databases searched

ISI Web of Knowledge (incl. ISI Web of Science and ISI Proceedings), Science Direct, Blackwell Synergy, IngentaConnect, Directory of Open Access Journals, COPAC, Scirus (All journal sources), Scopus, Index to Theses Online, Digital Dissertations Online, Agricola, CAB Abstracts, English Nature's "Wildlink", CEH online database (Centre for Ecology and Hydrology), JSTOR, www.ConservationEvidence.com, and Conserve Online.

Search Terms Used

Spartina, Spartina AND (control OR eradication), Spartina alterniflora, Spartina anglica, Spartina densiflora, Spartina patens, Spartina x townsendii, Cordgrass, and Ricegrass.

Other Searches

In addition further internet searches using www.alltheweb.com, and http://scholar.google.com (Google Scholar Beta), including searches for specific file types (pdf, doc and xls) were undertaken. The following statutory bodies and NGOs websites were searched: English Nature, Scottish Natural Heritage, Countrywide Council for Wales, Joint Nature Conservation Committee, Defra, National Trust, Environment & Heritage Service Northern Ireland, US Fish & Wildlife Service & various state environment departments in USA and Australia. All searches were conducted during the first quarter of 2006.

Study Selection Criteria

Studies were included if they fulfilled the following selection criteria:

Subject

The following Spartina sp.: *S. alternifolia* (Smooth or "Atlantic" Smooth Cordgrass) + *hybrids, S. anglica* (Common or "English" Cordgrass)*, S. densiflora* (Chilean Cordgrass)*, S. patens* (Saltmeadow Cordgrass), *S. x* townsendii (Townsend's Cordgrass).

Interventions of Interest
Hand Pulling & Manual Excavation, Mechanical Excavation & Dredging, Mowing, Crushing & Mechanical Smothering, Covering or Blanketing, Flooding or Draining, Salinity Adjustments and Herbicide (aerial, boat or ground application methods) and any combination of the above methods.

Outcome Measures
Change in cover, density, frequency or biomass, or a measure of change in any plant characteristic.

Types of Study (Comparator)
Any randomised block design, control trial, site comparison or before and after time series experiment.

Data Collection and Analysis
A three phase study inclusion assessment was preformed and the observed agreement between two independent reviewers was calculated to be "substantially good". Cohen's D effect sizes were calculated for each data point where the mean, number of replicates and standard deviation were known for both a treatment (management intervention) and control (untreated) plot. Standardized mean difference, DerSimonian-Laird (*random effects*) pooled *d+* meta-analysis was used to combine the effect sizes across all studies and test their level of significance. In addition datasets with only the means of the treatment and control recorded where analysed along with meta-analysable data of similar type to calculate the mean percentage decline ± standard deviation of that *Spartina* due that that specific management intervention.

Main Results
Control of *S. alterniflora* densities with glyphosate was highly effective with significant results from the meta-analysis of ground sprayed glyphosate (d+ = -3.065; 95% CI= -4.144 to -1.986; $p < 0.0001$). With June/July applications of 38 kg ae/ha being more effective than either similar concentrations at different times of the year or lower active ingredient concentrations. Multiple years of application only marginally increased the herbicides effectiveness, however if a years application is missed then reduction in density drops below 50%. The use of 1-5% wetter or surfactant with the glyphosate application improved the impact of the (d+ = -6.240; 95% CI = -8.988 to -3.492; $p < 0.0001$). Control of *S. anglica* densities with glyphosate was not as effective as those achieved against *S. alterniflora.* (43% and 58% decline respectively, Fig 2a), however the highest concentration of glyphosate active ingredient was 1.8 kg ae/ha, which was also not significant at decreasing *S. alterniflora* densities.

Imazapyr application had the greatest impact in controlling *S. alterniflora* densities (d+ = -3.208; 95% CI = -3.889 to -2.527; $p < 0.0001$), with lower concentrations of active ingredient (1.7kg ae/ha) required to achieve superior density reductions (0.85) reductions than glyphosate (0.58). The addition of a surfactant/wetting agent increased imazapyr effectiveness (d+ = -5.768; 95% CI = -7.354 to -4.181; $p < 0.0001$).

Control by cutting only, significantly reduced the density of *S. alterniflora* (d+ = -4.853; 95% CI = -9.093 to -0.614; $p = 0.0248$) with the mean decline of 68.1% ± 35.4sd. However, *S. anglica* densities actually increased over a years follow-up (d+ = 0.594; 95% CI = -0.765 to 1.952; $p = 0.3918$) with a mean proportional decline of = -

0.428 ± 0.487sd, therefore increasing the mean density of *S. anglica* by 42.8%. Cutting and then smothering was only used against *S. anglica*, but was highly significant at reducing its density (d+ = -4.307; 95% CI = -5.799 to -2.814; $p < 0.0001$) with the greatest mean decline of 97.9% achieved by any management intervention within this systematic review against this species.

The use of mechanical tracked vehicles or specially adapted rollers to crush *S. alterniflora* provided significant declines in densities (d+ = -1.951; 95% CI = -3.033 to -0.870; $p < 0.0004$), with a mean decline of 61.2%. The addition of glyphosate, applied up to six weeks after the crushing event provides a highly significant reduction in crush *S. alterniflora* densities (d+ = -3.806; 95% CI = -5.967 to -1.645; $p < 0.0006$), with a mean percentage decline of 91.1%. Tilling, to work the substrate to improve its structure and drainage achieved the best control of *S. alterniflora* densities of all mechanical control methods (d+ = -5.108; 95% CI = -9.804 to -0.413; $p < 0.033$) with the greatest mean declines in densities of all management interventions undertaken to control *S. alterniflora* (96.5%).

The use of ungulates (hoofed grazing animals) was not effective at reducing the densities of *S. alterniflora* (d+ = -0.702; 95% CI = -2.679 to 1.275; $p < 0.4865$) with a mean percentage decrease of 24.4%. The use of *Prokelisia* spp. (planthoppers) was effective at reducing *S. anglica* densities by a mean percentage decrease of 92.5. However, they were required in large numbers (>2,000 per $0.5m^2$). But, *Prokelisia* spp. were not very effective against *S. alterniflora* with only a 18.4% density decline.

Conclusions

Due to the lack of reporting of key methodological and environmental variables only a partial investigation of the possible sources of heterogeneity could be completed, for example not all studies reported information such as the month that control was undertaken, the number of hours before tidal immersion after a herbicide was applied, or the substrate of the site. This limitation of both in-house monitoring and of contractors, employed to undertake large scale control programmes, has been noted previously by Patten (2002; 2004).

Implications for Policy Makers and Practitioners

The available evidence (summarised in Table 3) suggests that to achieve a successful control programme, management interventions should be specifically targeted in regards to the species that are to be targeted. For example bio-control was found to be highly effective (92.5%) against *S. anglica*, but its effectiveness was remarkably reduced against *S. alterniflora* (18.4%).

Imazapyr and glyphosate were by far the most commonly used management intervention by practitioners. Imazapyr achieved 85.1% density reductions of *S. alterniflora* while not assessed against *S. anglica*, and glyphosate achieved 57.9% density reductions against *S. alterniflora* and 42.8% against *S. anglica*. The addition of a surfactant/ wetting agent increased the effectiveness of both herbicides by an additional 8-12%. In addition, of these two herbicides, imazapyr provides greater control of *S. alterniflora* at lower concentrations with a smaller drying time required than glyphosate. The most effective herbicides against *S. anglica* were fenuron (88.2%) and aminote-T (75.8%), but both had small datasets and require further trials prior to extensive use.

Cutting alone is not an effective control intervention of *S. anglica*, produced an overall increase in stem density of 42.8%. However when cutting is combined with a smothering element such as industrial black plastic sheeting then this control methodology was highly significant, achieving declines of on average 98% (Table 3). In addition Hammond & Cooper (2003) reported that cutting and smothering was also the only management intervention which caused a decline in dry root weight. For the control of *S. alterniflora* both cutting only and cutting with glyphosate were effective at controlling densities (68% and 91% decline in density respectively).

Spartina management programmes, with the purchase of an amphibious tiller (~ £150,000), and is slow to implement (~0.25 ha/hr reported by Patten 2004). Crushing is less expensive than (~ £50,000), and in addition is quicker than tilling (1-2hr/ha), but for more effective control two or more treatments are required in one year (see Table 3).

Herbivory of *Spartina* spp. by ungulates (e.g. horses/cattle/deer) has been carried out for decades with little impact. However the use of a species such as *Prokelisia marginata* (a planthopper) as a classic biological control agent is still in its infancy and due to the limited number of datasets, further research into their use in controlling *S. alterniflora* and more promisingly against *S. anglica* should be investigated.

The Implications for Further Research

There are numerous confounding variables which operate within an estuarine environment. The majority of experiments captured had an insufficient number of replicated to assess the impact of many of these sources of heterogeneity in a robust manner. The length of experimental follow-up should be standardised. The majority of practitioners aren't concerned whether or not a control intervention has worked within the first couple of months, but instead require medium (10-12 months) and long term evaluations (2+ years) after control to assess whether a repeat treatment should be undertaken or a different control intervention be considered.

Further experimental evidence is required to fully establish the efficacy of a number of control interventions. These include the herbicides (paraquat, 2,2-DPA, aminote-T, fenuron, and diuron) cut and glyphosate, cut and smother and the herbivorous planthoppers (*Prokelisia* spp.). Experiments investigating the control of *S. townsendii* and *S. patens* were sparse, further research into control of these species is required as outside of their native range they pose very similar problems to the more dominant *S. alterniflora* and *S. anglica*.

In addition to the above, the basic reporting of the site characteristics and methodology of experimental trials should be improved to include at the very least the month that the management intervention was undertaken. For herbicide trials the drying time before immersion is also an important variable for a practitioner to know, as small drying times significantly reduce the efficacy of glyphosate. For mechanical control the substrate of the site is also important as considerable affect to the effectiveness of the management intervention. If these potential reasons for heterogeneity are not reported within papers and/or reports then the practitioner could waste limited resources undertaking a management intervention that is not optimised to their particular situation.

CONTENT PAGE

1. BACKGROUND

Estuarine environments support ecologically important expanses of tidal mudflats and salt marshes. These environments support a diverse array of plants and animals many of which are specialised to these environments. Due to increased global trade over recent decades, many non-native species of plants and animals have been introduced to estuarine environments e.g. via. ship ballast water exchange (CSCC, 2003). Some species now threaten to cause fundamental shifts in the structure and function of major estuarine tidal lands. Among these hostile invaders are several species of salt marsh cordgrass (genus *Spartina*). In recent decades, populations of non-native *Spartina* have been introduced (both deliberately and accidentally) to the estuaries around Europe, U.S.A., Australia, New Zealand and temperate Asia, and began to spread rapidly. Though important in their native settings, and in the past used in extensive coastal protection and land reclamation projects (Allan, 1930; Chung, 1993), these non-native *Spartina* species are highly aggressive in their new environment, and frequently become the dominant plant species in areas they invade.

Spartina anglica (common or "English" cordgrass) and *S. x townsendii* (Townsend's cordgrass) first originated in the U.K. at Hythe, Southampton water in the nineteenth century (Hubbard, 1957; Goodman *et al.* 1969; Gray *et al.* 1991). *S. anglica* was the resulting fertile hybrid produced by the chromosome doubling of *S. x townsendii*, (the sterile hybrid of the European native, *S. maritima*) and the introduced *S. alterniflora*. Within a century of its origin, common cordgrass has become the dominant salt marsh grass in Britain (Gray *et al.* 1991). It is shorter and more greyish than *S. alterniflora*, with vigorously spreading rhizomes and can transform mudflats into vast stands of low marsh vegetation. It dominates the marsh and displaces the associated plant species. This species has spread around Europe, USA and Australasia.

S. alterniflora (smooth or "Atlantic" smooth cordgrass) is closely related to *S. foliosa*. In Northern America it occurs along both the eastern and western coastlines and the Gulf Coast nations (Gleason & Cronquist, 1991). It is one of the most aggressive *Spartina* species (in USA) and has high growth potential and ecological breadth, and is the parent species of the other most invasive cordgrass species *S. anglica* (most aggressive in Europe). It spreads both by seed dispersal and by rhizomes forming extensive clonal colonies in a circular layout if viewed overhead. In areas of the San Francisco estuary, the rate of lateral spread by rhizomes averages between 1 to 2 metres annually (3.3 to 6.6 feet), in contrast to the native *S. foliosa*, which has an annual spread of between 0.2 to 0.7 metres (0.6 to 2.4 feet) per year at the same locations (Josselyn *et al* 1993; CSCC, 2003) with a highly variable height range, depending upon its local environment and genetics. In the tidal salt marshes of the Atlantic coastline of Northern America *S. alterniflora* is dominant over most of the intertidal zone, even growing below mean low water in some areas (McKee & Patrick, 1988), and occupying, sometimes dominating the marsh plain and the low marsh. It is highly resilient, tolerating salinity of 45+ parts per thousand (greater than ocean salinity), and also thriving in brackish water. It can be buried and regenerate from 0.3m of deposited sediment (Zaremba, 1978).

Hybridization has occurred between *S. alterniflora* with *S. foliosa* in North America. Within the San Francisco Estuary population of *S. alterniflora* a rapid evolution of an aggressively expanding hybrid, formed by cross pollination with the native *S. foliosa* of the area (Daehler and Strong 1997). Both species act as pollen-parent and seed

parent to the new hybrid form. The hybrid form produces a greater quantity of pollen (21 times greater) and has a higher fertility than the parent *S. foliosa*. Pollen swamping of the native *S. foliosa* occurs frequently so that the native stands produce predominantly hybrid introgressant seeds, and fail to sexually reproduce the species (Ayres et al. 1999, Antilla et al. 2000). This process, called "hybrid assimilation", can singularly result in the extinction of the native species (Levin et al. 1996, Rhymer and Simberloff 1996). Genetic analysis of *S. alterniflora* in San Francisco estuary has revealed that the majority of populations presumed to be "pure", are principally hybrid or introgressant stands with "pure" *S. alterniflora* in the minority. This trend implies that hybrids will in due course replace both parent species, as *S. anglica* did in the U.K.

Non-native invasive *Spartina* can have long-term effects on the coastal environments. Once seedlings are established within a marsh, their rapid spread causes extensive regional losses of tidal mud flats and the exclusion of native species. *Spartina* invasions have been attributed to the loss of *Zostera* beds (Ranwell & Downing 1959; Gray & Raybould 1997) and are known to out-compete *Salicornia* spp. (Nairn 1986). Elimination of foraging habitat for waders and fish; alteration of natural sedimentation processes (incl. estuarine beaches and beach forming processes); loss of tidal sloughs and channels; an increase in dredging and flood control works and extinction of native flora and fauna (Hammond, 2001; CSCC, 2003).

Various methods have or are being tested for use in control and/or eradication of invasive *Spartina* species. These include a number of manual, mechanical and chemical methods. Some are designed to totally eradicate target *Spartina* populations, while other methods provide a temporary control of the species or are designed to aid the implementation of a removal method.

Using systematic review methodology, the different methods used to control or eradicate *Spartina* will be critically appraised. The review will consider all available primary experimental evidence of the different control and eradication methods. Bias will be limited through comprehensive searching of both published and unpublished "grey" literature, specific study inclusion criteria, and formal assessment of the quality and reliability of the studies retrieved. Subsequent quantitative and qualitative data synthesis will be utilised to summarise the available evidence while also highlighting any gaps in the research evidence found to direct future research programmes.

2. OBJECTIVES

To investigate the effectiveness of management interventions used to control the abundance or completely eradicate invasive *Spartina* species and to analyse, when possible, the effects that potential sources of heterogeneity (e.g. substrate type) have on the results

3. METHODS

3.1. Question Formulation

The need for a systematic review on control of *Spartina* sp. was identified through consultation with a number of stakeholders who undertake management actions against *Spartina* on an annual basis, but are concerned that their management practices are not being effective at controlling or in some cases completely eradicating invasions. An initial draft protocol was developed and circulated to stakeholders for comment. After further consultation, including follow-up one-to-one discussions, a finalised version of the protocol was posted online (www.cebc.bham.ac.uk) stating the objectives of the review (see above), the search strategy and criteria for the inclusion and exclusion of studies within the review (see below) and the possible approaches which could be used for data analysis in light of the number of datasets available.

3.2. Search Strategy for Identification of Studies

The search strategy was designed to be inclusive, so that all references to *Spartina* control/eradication efforts and additionally how such interventions altered wetland habitats were captured. To achieve this end a broad spectrum of online literature databases were searched to identify relevant articles and reports:

1. **ISI Web of Knowledge** (**WoK**) using the CrossSearch Form on the following products: ISI Web of Science and ISI Proceedings.
2. **Science Direct** – Agricultural and Biological Sciences.
3. **Blackwell Synergy**
4. **IngentaConnect**
5. **Directory of Open Access Journals**
6. **COPAC**
7. **Scirus (All journal sources)**
8. **Scopus**
9. **Index to Theses Online**
10. **Digital Dissertations Online**
11. **Agricola**
12. **CAB Abstracts**
13. **English Nature's "Wildlink"**
14. **CEH online database** (Centre for Ecology and Hydrology)
15. **JSTOR**
16. **ConservationEvidence.com**
17. **ConserveOnline**

The following search terms were used on all the above databases to identify possibly relevant articles to achieve the reviews object.

1. ***Spartina***
2. ***Spartina* AND (control OR eradication)**
3. ***Spartina alterniflora***
4. ***Spartina anglica***
5. ***Spartina densiflora***
6. ***Spartina patens***
7. ***Spartina x townsendii***
8. **Cordgrass** (common name used in Europe and U.S.A.)
9. **Ricegrass** (common name used in Australasia)

In addition to the online databases, further general internet searches using www.alltheweb.com, and http://scholar.google.com/ (Google Scholar Beta) were undertaken for the identification of further articles and unpublished (grey) literature e.g. in-house reports. In all cases only the website that was captured by the search engine was assessed, in the order which they appeared, (no links were followed from identified sites except to pdf or data files). Searches were completed for each of the search terms four times (standard search, pdf files only, doc/txt files only, and xls/excel files only). The first 50 "hits" each being assessed for their relevance against the study inclusion criteria (see 3.3).

The following statutory bodies and non-governmental organisations (NGOs) were inspected for further relevant material including pertinent grey literature or unpublished datasets: English Nature, Scottish Natural Heritage, Countryside Council for Wales, U.K. Joint Nature Conservation Committee, U.K. Department of Environment, Food and Rural Affairs, National Trust (U.K.), Environment & Heritage Service Northern Ireland, US Fish & Wildlife Service and various state environment departments in USA and Australia. All searches were conducted during the first quarter of 2006.

The results of each search term on each database were imported into a separate EndNote™ library file. After all searches for a particular database were completed an overall database library was compiled, including all duplicates. All the database libraries were then incorporated into an overall online database library, recording the number of references captured. The same procedure was followed for reports and articles identified via internet searches and organisation searches. An overall library of all identified sources was finally compiled for the removal of duplicate references and the applicability of each study towards answering the reviews objectives.

3.3. Study Inclusion Criteria

All references underwent a number of filtering processes for their inclusion within the final review and data analysis (see Fig 1). First, all duplicates were removed using both the auto removal feature in EndNote™ and by hand searching. Second, a course title and abstract filter was undertaken to identify references that focused on one or more *Spartina* species or on the management of saltmarsh/wetland areas. Any reference which the reviewer was unsure of, due to lack of information contained within the title or abstract, were accepted through to the full text assessment stage. In addition, a subset of approximately 25% of the reference were assessed independently

by a second reviewer; agreement on inclusion between the reviewers were considered to be "substantially good" Cohen's Kappa, $K = 0.725$ (Landis & Koch; 1977), with any disagreements being discussed between the two reviewers.

Finally for an article to be included within the final review it was required to meet the following full text inclusion criteria:

Subject
One or more of the following *Spartina* sp.:
S. alternifolia (Smooth or "Atlantic" Smooth Cordgrass) + *hybrids, S. anglica* (Common or "English" Cordgrass)*, S. densiflora* (Chilean Cordgrass)*, S. patens* (Saltmeadow Cordgrass), and *S. x* townsendii (Townsend's Cordgrass).

Interventions of Interest
One or more of the following control/eradication management interventions:
Hand Pulling & Manual Excavation, Mechanical Excavation & Dredging, Mowing, Crushing & Mechanical Smothering, Covering or Blanketing, Flooding or Draining, Salinity Adjustments and Herbicide (aerial, boat or ground application methods) and any combination of the above methods.

Outcome Measures
Either a measure in the change in the abundance of: cover, density, frequency, biomass or a measure of any plant characteristic (e.g. height of plant, leaf elongation).

Types of Study (Comparator)
Any randomised block design, control trial, site comparison or before and after time series experiment was accepted through to the final review analysis.

Attempts were made to contact first authors of accepted articles, if any questions arose concerning the clarification of the reported results, missing data values or further explanation of their methodology or findings.

3.4. Data Extraction & Study Quality Assessment

Data as presented within the original articles were extracted onto a 'study methodology' form (see Appendix 3 for completed forms). Information extracted included:

1. A brief description of the methods used to obtain the data,
2. Details of the study *Spartina* species,
3. Details of the interventions (including type of management practice undertaken; the duration, the substrate of the site (if presented); and any additional interventions on the management practices e.g. month of management, amount of herbicide or confounding interventions undertaken at the same site),
4. Outcome measures recorded,

The mean, sample size and standard deviation for each of the outcome measures given were calculated at the plot scale (not the individual plant scale as presented in some of the articles) for both the experimental and control arms of each experiment.
All articles included within the systematic review had their methodological quality assessed against a hierarchy of evidence adapted from Stevens and Milne (1997) and

Pullin and Knight (2001). This involved assessing each of the article's experimental designs, including the baseline comparisons, treatment variations, parameter of abundance, scale of experiment and the level of replication undertaken. Differences between experiments were considered as potential reasons for heterogeneity and, when adequate amounts of data were presented, investigated further to assess their impact of the outcomes of the review.

3.5. Data Synthesis

Data from both intervention and control plots of each study were combined using meta-analysis. This approach allows individual studies to be synthesised to give the overall effect of an intervention (Gurevitch & Hedges; 1999). Any missing variance values were extrapolated using the mean substitution method (Roth & Switzer, 1995), with the mean value of the other variances from those data points involved in that particular meta-analysis replacing the missing values.

The datasets were firstly sorted into the different management intervention subgroups and then by the outcome measures. Separate meta-analyses were firstly undertaken for each of the management interventions (irrespective of *Spartina* species), and re-analysed for each of the species. Cohen's D effect sizes (Egger *et al.* 2003; Sutton *et al.* 2000) were calculated for each study where the mean, number of replicates and standard deviation was known. Standardized mean difference, DerSimonian-Laird (random effects) pooled effect *d*+ meta-analysis was used to combine the effect sizes across all studies (Eggar *et al.* 2003). This method expresses the size of the treatment effect in each study relative to the variability observed in that study, allowing different abundance measures to be combined allowing them to effectively be analysed against the same scale (Deeks *et al.* 2001).

Prior to each of the meta-analyses, heterogeneity was assessed by the use of Forrest plots and formal tests of heterogeneity "Q" (non-combinability for d+) (Thompson and Sharp 1998). Publication bias was also assessed using Funnel plots of asymmetry along with formal tests, to see the effect of the inclusion and exclusion of grey literature and non-English language studies (Eggar *et al.* 2003).

Approximately 30% of the synthesised articles or individual experiments could not be included within the formal meta-analysis due to the lack of details reported on their methodology and their summary statistics (e.g. presenting only an overall percentage control figure, with no details of number of replicated plots and measure of variance). However, these experiments have been synthesised, along with those included within the meta-analyses in a descriptive analysis of the mean (± 1 standard deviation) of the proportion of decline of each *Spartina* species under each management intervention.

4. RESULTS

4.1. Description of Studies

The searching of all electronic databases and the internet produced 11301 references (Fig 1). After duplicates were removed a total of 5213 unique references remained for assessment at title and abstract stage, of which 318 were potentially relevant and required for full text assessment against the study inclusion criteria (see above). Full text assessment yielded a total of 46 articles that were relevant for inclusion within the systematic review. Of the 46 articles, 25 investigated the effect of management interventions on *S. alterniflora*, 11 focused on *S. anglica*, six on *S. patens*, four on *S. townsendii* and two on *S. densiflora* (N.B. an article could study more than one species).

With respect to the management interventions utilised to control/eradicate *Spartina*, 33 articles investigated the effects of the use of herbicides, 17 articles were on herbivory of *Spartina,* eight articles on mechanical control methods (mowing, tilling, disking, and crushing), seven articles on the impacts of changing salinity of the water, five on flooding, three on cutting by hand, one on burying and one on hand-pulling (sometimes referred to as hand operation). See Appendix One for a summary of each of the included articles.

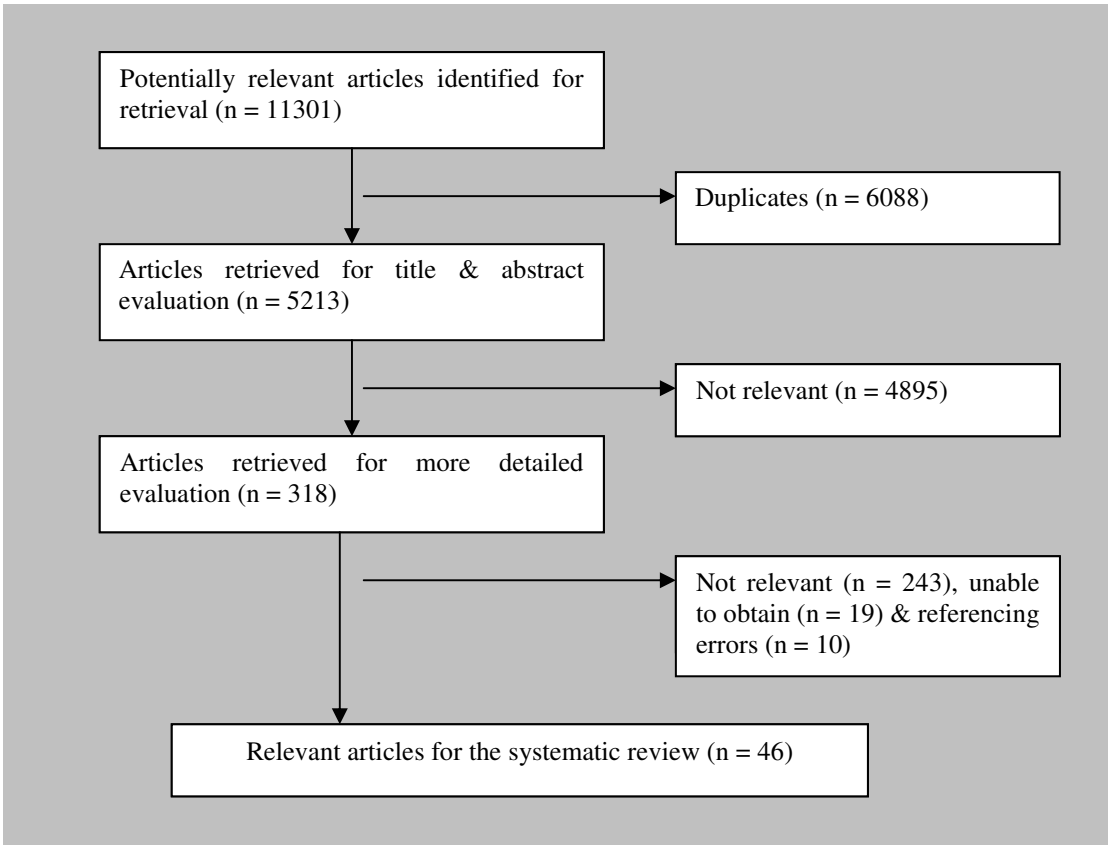

Fig. 1 Results of literature search and study selection process showing the final number of articles included in the systematic review. Values (n) are the number of articles at each stage (QUOROM statement flow diagram – see Moher *et al* 1999).

4.2. Statistical analysis outcomes

4.2.1. The Impacts of Herbicide

The individual meta-analysis results for herbicide applications are shown in Table 1 and for all datasets Fig. 2a (density results). The majority of data captured investigated the impact of either glyphosate (on *S. alterniflora* or *S. anglica*) or imazapyr (on *S. alterniflora* only).

4.2.1.1. Glyphosate

Control of *S. alterniflora* densities with glyphosate was highly effective with significant differences between treatment and control from the meta-analysis of all datasets (pooled effect size d+ = -2.823; 95% confidence intervals = -3.916 to -1.986; p = <0.0001, Table 1). As results show there was a great deal of inconsistency (heterogeneity) within the datasets which was investigated further. Aerial application of glyphosate did not significantly reduce the density of *S. alterniflora* (d+ = -0.812; 95% CI= -5.175 to 3.551; p = 0.7153) as the 95% confidence intervals crossed the line of no effect (zero line). However, ground sprayed glyphosate did significantly reduce *S. alterniflora* density (d+ = -3.065; 95% CI= -4.144 to -1.986; p < 0.0001). With June/July applications of 38 kg ae/ha being more effective than either similar concentrations at different times of the year or lower active ingredient concentrations. Multiple years of application only marginally increased the herbicides effectiveness, however if a years application is missed then reduction in density drops below 50%. The use of 1-5% wetter or surfactant with the glyphosate application improved the impact of the (d+ = -6.240; 95% CI = -8.988 to -3.492; p < 0.0001).

Control of *S. anglica* densities (all data) with glyphosate was not as effective as those achieved against *S. alterniflora.* (43% and 58% decline in densities respectively, Fig 2a), however the highest concentration of glyphosate active ingredient was 1.8 kg ae/ha, which was also not significant at decreasing *S. alterniflora* densities. Meta-analysis results of all data confirmed that densities were not significantly reduced (d+ = -0.15; 95% CI = -0.505 to 0.201; p = 0.3995). However with the addition of a wetting agent (mixture B) a significant reduction in the density of *S. anglica* is achieved (d+ = -0.789; 95% CI = -1.567 to -0.011; p = 0.0468) and the above ground biomass of *S. anglica* significantly reduced (d+ = -3.820; 95% CI = -5.60 to -2.04; p < 0.0001), with July applications having the greatest impact and September application not having a significant impact.

4.2.1.2. Imazapyr

From all the data captured, imazapyr application had the greatest impact in controlling *S. alterniflora* densities (85% decline, Fig 2a). Meta-analysis of complete datasets also confirmed that imazapyr application was significant at reducing *S. alterniflora* densities (d+ = -3.208; 95% CI = -3.889 to -2.527; p < 0.0001), with lower concentrations of active ingredient (1.7kg ae/ha) required to achieve superior density reductions than glyphosate (38kg ae/ha). The addition of a surfactant/wetting agent greatly increasing imazapyr effectiveness (d+ = -5.768; 95% CI = -7.354 to -4.181; p < 0.0001).

4.2.1.3. Other herbicides

A number of other herbicides were captured by the search strategy, these are briefly summarised for completeness of the review, to provide practitioners with details that these herbicides have been trialled against *Spartina* spp. but also to highlight that further experiments are required to establish their effectiveness.

2,2-DPA

Meta-analysis of available datasets showed that 2,2-DPA did not significantly reduce the density of *S. alterniflora* (d+ = -0.708; 95% CI = -1.550 to 0.133; p = 0.099) with a mean percentage decline in densities of 50.5% ± 41.5sd (Fig. 2a). Additionally, two datasets investigated the application of 2,2-DPA to control *S. townsendii* with mean percentage decline in densities of 61.1% ± 41.2sd (Fig. 2a).

Amitrole-T

Amitrole-T applications did not significantly reduce *S. alterniflora* densities (d+ = -0.577; 95% CI = -1.404 to 0.250; p = 0.01715) with an average percentage decline in density of 38.9% ± 33.4sd (Fig. 2a). Full datasets were not available to undertake meta-analysis against other *Spartina* spp. However, the average percentage decline in *S. anglica* densities = 75.8% ± 24.1sd, and *S. townsendii* densities = 4.0% ± 22.1sd (Fig. 2a).

Dalapon

The greatest reduction of *S. townsendii* densities was achieved with dalapon applications (97.5% ± 5.0sd). If two or more treatments are applied within the same year then complete eradication of *S. townsendii* was achieved after one years follow-up (Fig 2a).

Diuron

Four datasets were available for investigating the effectiveness of diuron application to reduce the density of *S. alterniflora*. This herbicide was found to be the least effective of all assessed within the review (d+ = -0.034; 95% CI = -1.024 to 0.956; p = 0.9462), with an average density reduction of 1.4% a year after a single application (Fig 2a).

Fenuron

Fenuron application was used against *S. alterniflora* (58.0% reduction in density) and *S. townsendii* (64.5% reduction). In addition, Fenuron provided the greatest density decline of all herbicides against *S. anglica,* (88.2% average density decline).

Paraquat

Meta-analysis of available datasets showed that paraquat did not significantly reduce the density of *S. alterniflora* (d+ = -0.794; 95% CI = -1.630 to 0.041; p = 0.0623) with a mean decline of 52.7% ± 16.7sd (Fig. 2a). Additionally, application of paraquat to control *S. townsendii* resulted in the mean percentage density decline of 61.6% ± 32.7sd (Fig. 2a). The age of the *Spartina* plant was considered to be an important

variable however only a limited number of authors reported this variable, with Taylor & Burrows (1968b) reporting a decrease in the susceptibility of *S. townsendii* to paraquat application with the age of the plant, flowering plants showing the lowest susceptibility and seedlings the highest.

4.2.2. The Impacts of Cutting

The individual meta-analysis results for the different cutting applications are shown in Table 2 and for all available datasets Fig. 2b (density results). Meta-analysis could only be completed for two species as complete datasets were available (*S. alterniflora* or *S. anglica*), however additional data were available for both species and for *S. townsendii* to perform the subsequent descriptive percentage decline of density analyses.

4.2.2.1. Cutting Only

Cutting only achieved significant reduction in the density of *S. alterniflora* (d+ = -4.853; 95% CI = -9.093 to -0.614; p = 0.0248) with the mean percentage decline in density of 68.1% ± 35.4sd. However, *S. anglica*, densities actually increased over a years follow-up (d+ = 0.594; 95% CI = -0.765 to 1.952; p = 0.3918) with a mean density increase of 42.8%. Similarly, for the one dataset available for *S. townsendii,* a 14.7% increase in densities was reported.

4.2.2.2. Cutting with Herbicide Application

The use of cutting and then dalapon application significantly reduced the density of *S. alterniflora* (d+ = -8.002; 95% CI = -11.081 to -4.923; p < 0.0001) and also significantly reduced the density of *S. anglica* (d+ = -3.826; 95% CI = -5.021 to -2.630; p < 0.0001).

The use of cutting and then glyphosate application increased the density of *S. anglica* (d+ = 0.249; 95% CI = -1.003 to 1.501; p = 0.6967) with an average increase of *S. anglica* densities by 19% per plot. However, there was an average of 91% reduction for *S. alterniflora* densities per plot.

4.2.2.3. Cutting and Smothering

This control method was used against *S. anglica* and significantly reduced its density (d+ = -4.307; 95% CI = -5.799 to -2.814; p < 0.0001). Cutting and Smothering achieved the greatest mean density decline against *S. anglica* (97.9%) by any management intervention within this systematic review.

4.2.3 Impact of Mechanical Control

The individual meta-analysis results for the different cutting applications are shown in Table 2 and for all available datasets Fig. 2c (density results). Meta-analysis could only be completed for *S. alterniflora* datasets, however additional data were available for this species and for *S. anglica* to perform the subsequent descriptive analyses of the average percentage decline of each species per population.

4.2.3.1. Crushing

The use of mechanical tracked vehicles or specially adapted rollers to crush *S. alterniflora* provided significant declines in densities (d+ = -1.951; 95% CI = -3.033 to -0.870; $p < 0.0004$), with a mean percentage decline of 61.2% per population. There was also considerable heterogeneity within the results, further analyse showed that: 1) The substrate type was important, with greatest control (>60% density reduction) achieved on sand and soft silt and <50% reduction in densities achieved on firm silt, and 2) The time of year was critical for the greatest impact, with winter interventions being twice as effective as those undertaken at other times during the year.

The addition of glyphosate, applied up to six weeks after the crushing event provides a highly significant reduction in *S. alterniflora* densities (d+ = -3.806; 95% CI = -5.967 to -1.645; $p < 0.0006$), with a mean density decline of 91.1%.

4.2.3.2. Disking

The use of disking to cut *S. alterniflora* in a shredding action also has the added compaction in some areas of crushing due to the tracks of the mechanical vehicle. This might account for the greater reduction in *S. alterniflora* densities achieved (d+ = -4.535; 95% CI = -8.371 to -0.700; $p < 0.0205$) with a mean density decline of 89.5%.

4.2.3.3. Tilling

The use of machines to work the substrate to improve its structure and drainage achieved the best control of *S. alterniflora* densities of all mechanical control methods (d+ = -5.108; 95% CI = -9.804 to -0.413; $p < 0.033$) Tilling also had the greatest mean percentage declines in *S. alterniflora* densities of all management interventions undertaken against this species (96.5% ± 2.2sd).

4.2.4. Impacts of Herbivory

4.2.4.1. Ungulates

The use of ungulates (hoofed grazing animals) was not effective at reducing the densities of *S. alterniflora* (d+ = -0.702; 95% CI = -2.679 to 1.275; $p < 0.4865$) with a mean percentage decrease of 24.4% per population. One dataset involved the use of ungulates to control *S. patens,* resulting in an 18.6% decrease of its density.

4.2.4.2. Prokelisia spp.

The use of *Prokelisia* spp. was effective at reducing *S. anglica* densities by 92.5%, but were required in large numbers (>2,000 per $0.5m^2$). However, *Prokelisia* spp. were not very effective at controlling *S. alterniflora,* decreasing population densities by only 18.4%.

Table 1 – Tabulated results of the meta-analyses for each of the herbicide applications experiments undertaken to control the density of Spartina species.

Overall Management Intervention	Species of Spartina	Further details	Total number within each arm of meta-analysis		Number of datasets	Pooled effect size (d+) 95% confidence intervals	Z (test d+ differs from 0)	I^2 (inconsistency of datasets)
			Treatment	Control				
Herbicide	*S. alterniflora*	2,2-DPA	12	12	6	-0.708 (95% CI = -1.550 to 0.133)	-1.650 P = 0.099	0%
		amitrole-T	12	12	6	-0.577 (95% CI = -1.404 to 0.250)	-1.367 P = 0.1715	0%
		diuron	8	8	4	-0.034 (95% CI = -1.024 to 0.956)	-0.067 P = 0.9462	0%
		glyphosate – all data	146	113	23	-2.823 (95% CI = -3.916 to -1.729)	-5.058 P < 0.0001	88%
		glyphosate – ground applied	116	83	20	-3.065 (95% CI = -4.144 to -1.986)	-5.567 P < 0.0001	83.3%
		glyphosate – ground applied with wetter/surfactant	58	53	8	-6.240 (95% CI = -8.988 to -3.492)	-4.450 P < 0.0001	93.2%
		glyphosate only (no wetter) – ground applied	51	30	12	-1.681 (95% CI = -2.226 to -1.137)	-6.051 P < 0.0001	0%
		glyphosate – aerial applied	30	30	3	-0.812 (95% CI = -5.175 to 3.551)	-0.365 P = 0.7153	96.6%
		imazapyr – all data	83	84	35	-3.208 (95% CI = -3.889 to -2.527)	-9.231 P < 0.0001	46.2%
		imazapyr only	69	66	29	-2.720 (95% CI = -3.385 to -2.055)	-8.019 P < 0.0001	38.3%
		imazapyr with wetter/surfactant	14	18	6	-5.768 (95% CI = -7.354 to -4.181)	-7.127 P < 0.0001	0%
		paraquat	12	12	6	-0.794 (95% CI = -1.630 to 0.041)	-1.864 P = 0.0623	0%
	S. anglica	glyphosate – all data	64	64	24	-0.152 (95% CI = -0.505 to 0.201)	-0.842 P = 0.3995	0%
		glyphosate – with R-11 surfactant	12	12	6	0.022 (95% CI = -0.784 to 0.828)	0.054 P = 0.9572	0%
		glyphosate – with mixture B surfactant	14	14	7	-0.789 (95% CI = -1.567 to -0.011)	-1.989 P = 0.0468	0%
		glyphosate only (no wetter/surfactant)	38	38	11	0.011 (95% CI = -0.444 to 0.466)	0.048 P = 0.9621	0%

Table 2 – Tabulated results of the meta-analyses for each of the cutting, mechanical & salinity experiments undertaken to control the density of Spartina species.

Overall Management Intervention	Species of Spartina	Further details	Total number within each arm of meta-analysis		Number of datasets	Pooled effect size (d+) 95% confidence intervals	Z (test d+ differs from 0)	I^2 (inconsistency of datasets)
			Treatment	Control				
Cutting	*S. alterniflora*	all data	60	60	6	-6.476 (95% CI = -9.546 to -3.406)	-4.135 P < 0.0001	92.8%
		cut only	30	30	3	-4.853 (95% CI = -9.093 to -0.614)	-2.244 P = 0.0248	94%
		cut & dalapon appl.	30	30	3	-8.002 (95% CI = -11.081 to -4.923)	-5.094 P < 0.0001	75.3%
	S. anglica	all data	96	96	16	-1.7430 (95% CI = -2.897 to -0.589)	-2.961 P = 0.0031	89.3%
		cut only	16	16	4	0.594 (95% CI = -0.765 to 1.952)	0.856 P = 0.3918	78.7%
		cut & glyphosate appl	16	16	4	0.249 (95% CI = -1.003 to 1.501)	0.390 P = 0.6967	76.1%
		cut & dalapon appl.	16	16	4	-3.826 (95% CI = -5.021 to -2.630)	-6.272 P < 0.0001	33.6%
		cut & smother	16	16	4	-4.307 (95% CI = -5.799 to -2.814)	-5.654 P < 0.0001	50%
Mechanical	*S. alterniflora*	all data	59	44	22	-2.715 (95% CI = -3.704 to -1.725)	-5.376 P < 0.0001	59.4%
		crushing only	27	22	11	-1.951 (95% CI = -3.033 to -0.870)	-3.536 P = 0.0004	47%
		crushing & herbicide	16	6	3	-3.806 (95% CI = -5.967 to -1.645)	-3.451 P = 0.0006	50.8%
		disking only	8	8	4	-4.535 (95% CI = -8.371 to -0.700)	-2.318 P = 0.0205	71.8%
		winter tilling only	8	8	4	-5.108 (95% CI = -9.804 to -0.413)	-2.132 P = 0.033	76.2%
Herbivory	*S. alterniflora*	ungulates (Horse & Cattle)	18	18	6	-0.702 (95% CI = -2.679 to 1.275)	-0.696 P = 0.4865	79.8%

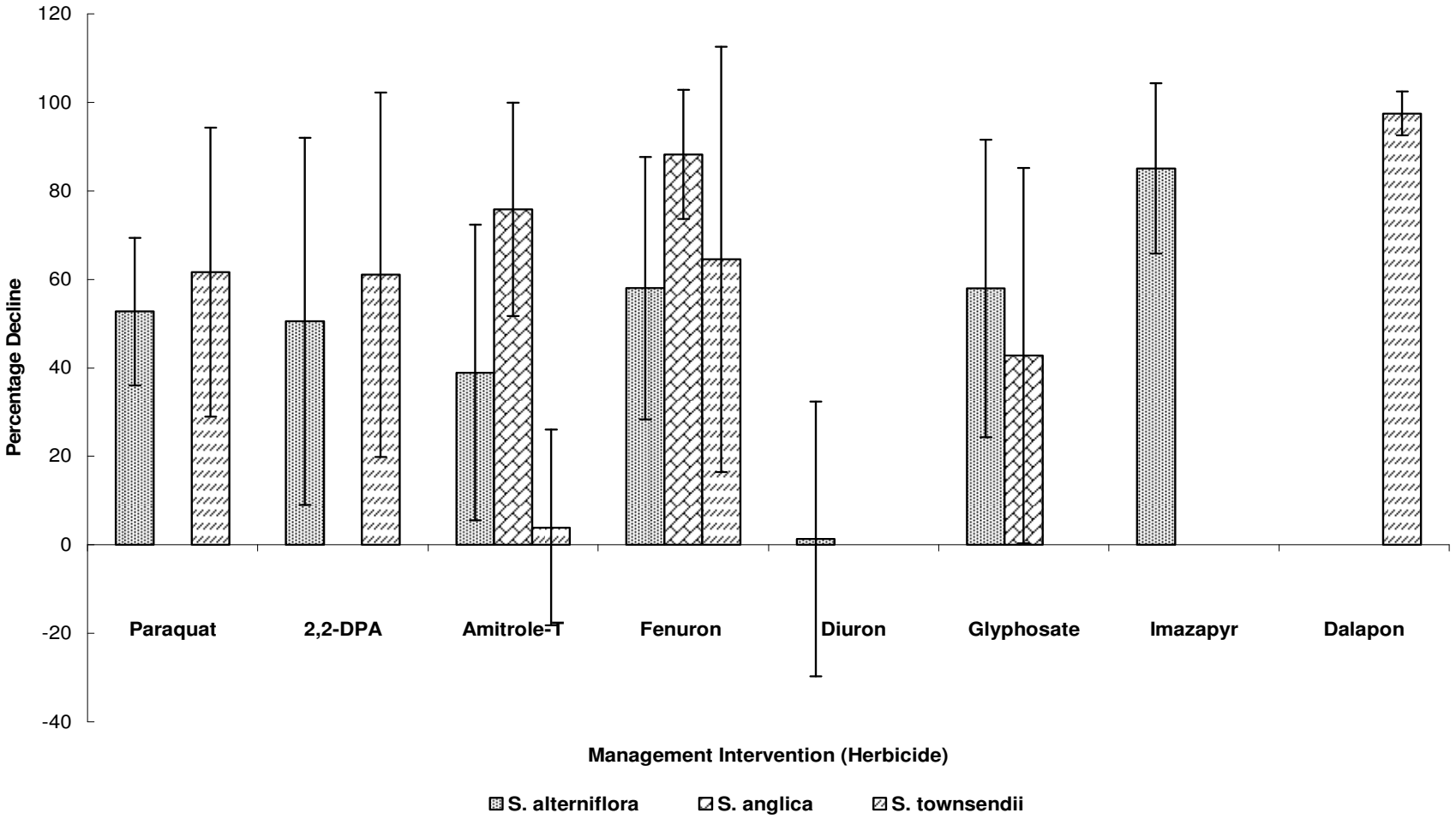

Fig. 2a - Herbicide

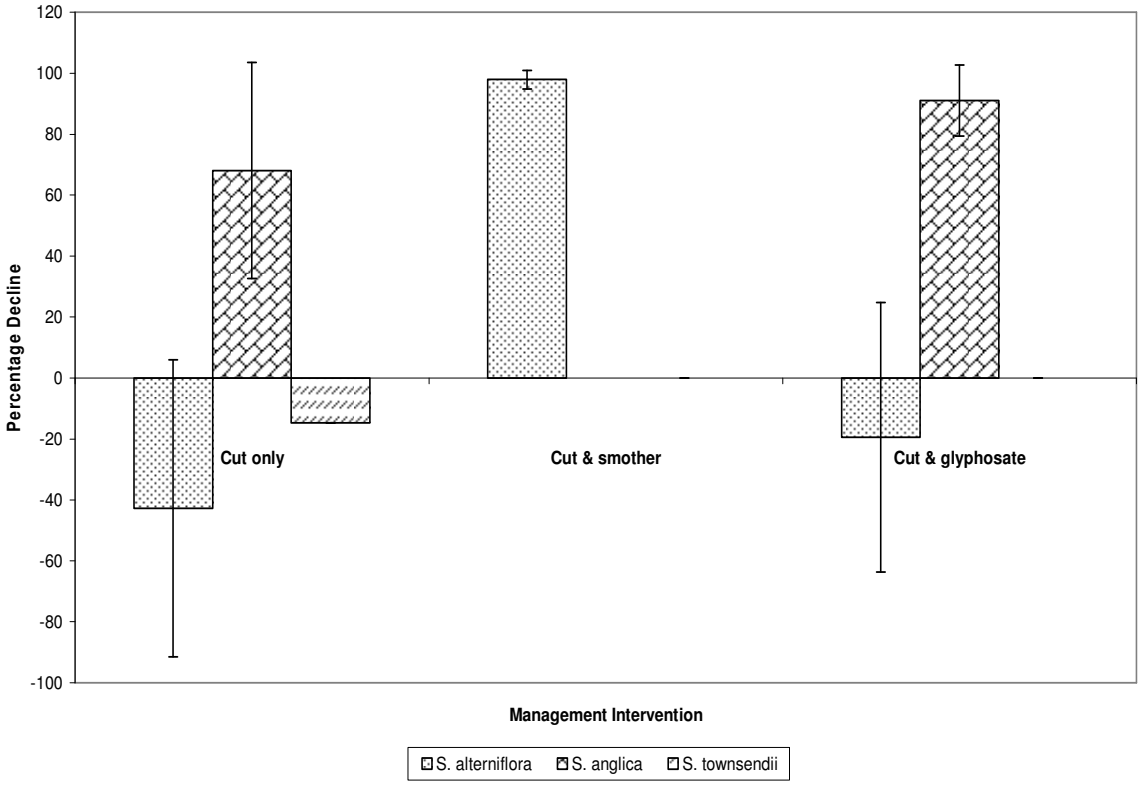

Fig. 2b - Cutting

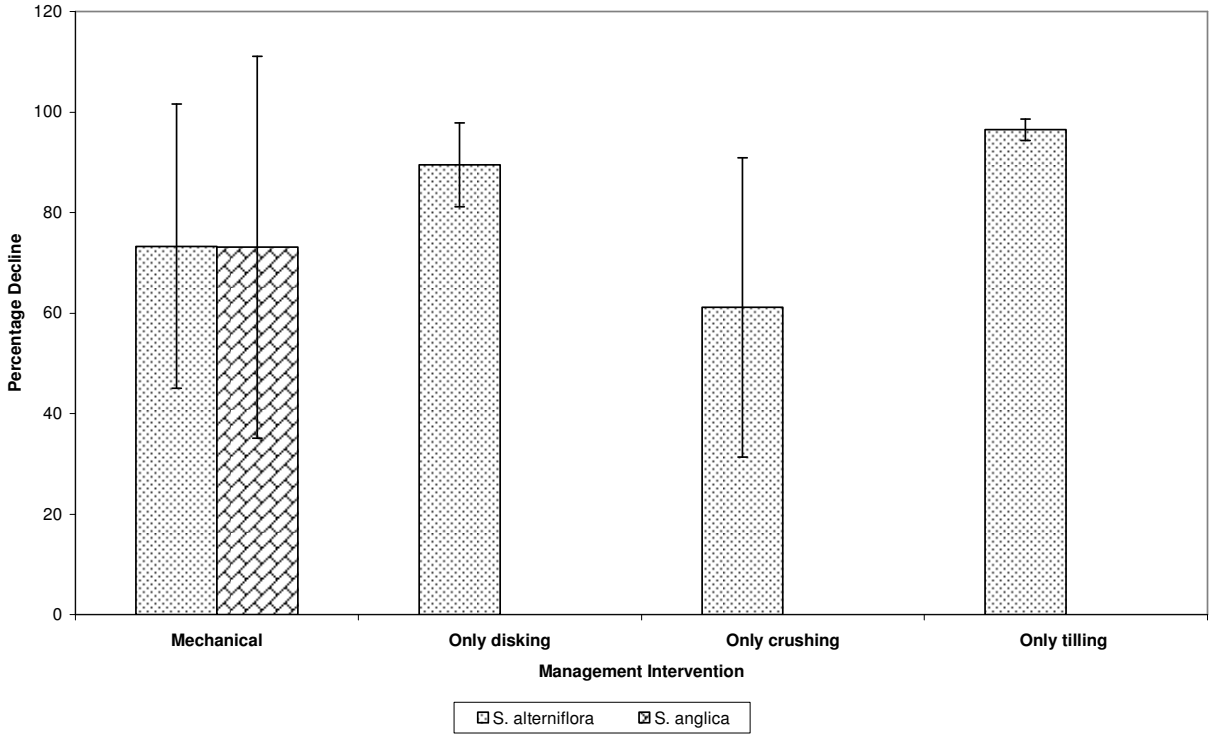

Fig. 2c - Mechanical

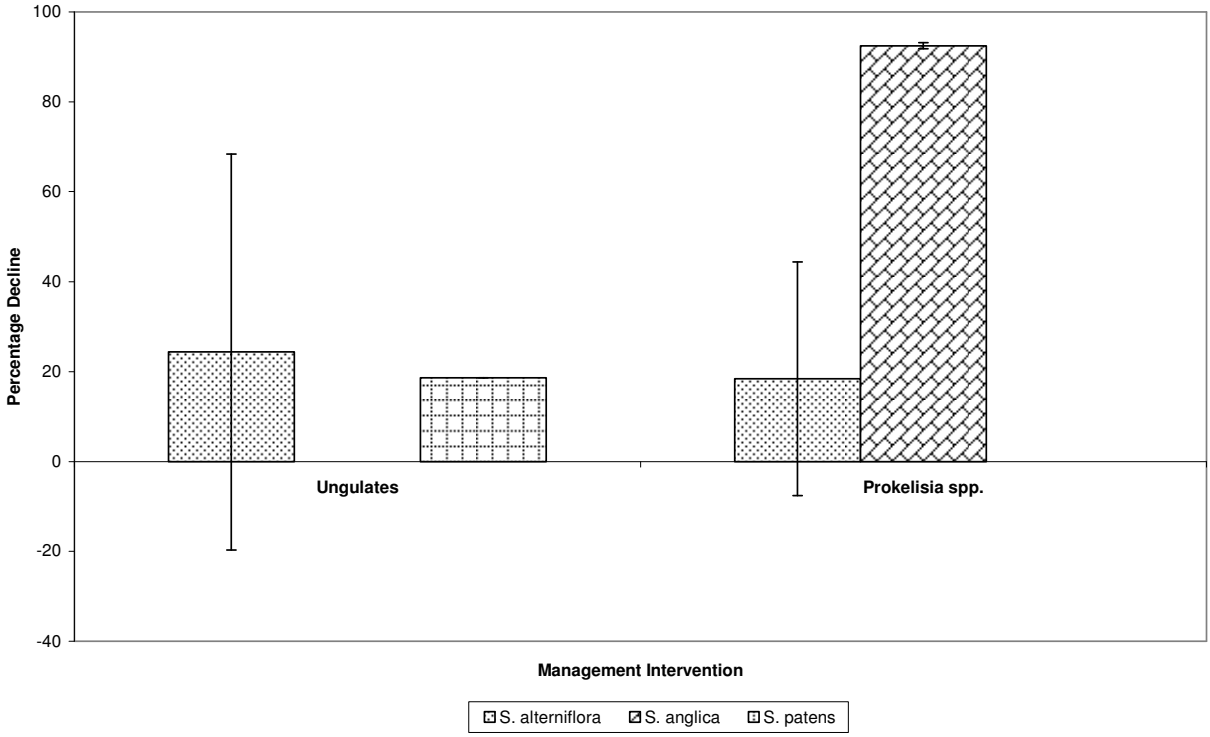

Fig. 2d - Herbivory

Fig. 2(a-d) Fig. 2(a-d) The percentage decline (±1 standard deviation) of Spartina species density, in light of management interventions – a) herbicide application, b) cutting, c) mechanical control, d) herbivory. N.B. scale differs per graph.

Table 3 - The effectiveness of the management interventions at reducing the densities of three species of *Spartina*.

Effectiveness of management intervention	*S. anglica*		*S. alterniflora*		*S. townsendii*	
100 – 75%	Cut & smother *Prokelisia* spp. (bio-control) Fenuron (herbicide) Aminote-T (herbicide)	97.9% 92.5% 88.2% 75.8%	Tilling Cut & glyphosate Crushing (2+ treatments) Disking Imazapyr (herbicide) Crush & glyphosate	96.5% 91.1% 91.0% 89.5% 85.1% 77.9%	Dalapon (herbicide)	97.5%
75 – 50%			Cut only Crushing (1 treatment) Fenuron (herbicide) Glyphosate (herbicide) Paraquat (herbicide) 2,2-DPA (herbicide)	68.1% 61.2% 58.0% 57.9% 52.7% 50.5%	Fenuron (herbicide) Paraquat (herbicide) 2,2-DPA (herbicide)	64.5% 61.6% 61.1%
50 – 0%	Glyphosate (herbicide)	42.8%	Aminote-T (herbicide) Ungulates *Prokelisia* spp. (bio-control) Diuron (herbicide)	38.9% 24.4% 18.4% 1.4%	Aminote-T (herbicide)	4.0%
Increased *Spartina spp.* density	Cut & glyphosate Cut only	-19.4% -42.8%			Cut only	-14.7%

5. DISCUSSION

This systematic review provides a detailed synthesis of available articles investigating the effectiveness of management interventions used to control the abundance or completely eradicate invasive *Spartina* species. It should be noted that in some of the meta-analysis there were large variations in the degree of heterogeneity between data-points (as provided by a high value for the I^2 statistic). Unfortunately, due to the lack of reporting of key methodological and environmental variables only a partial investigation of the possible sources of heterogeneity could be completed. For example, not all studies reported information such as the month that control was undertaken, the number of hours between herbicide application and tidal immersion, or the substrate of the site. This limitation of both in-house monitoring and of contractors, employed to undertake large scale control programmes, has been noted previously by Patten (2002; 2004).

There are a number of important factors that need considering prior to undertaking these management interventions. Firstly, how long is the treated area being exposed between tides? This is important for both herbicide application and mechanical operations. For example, Patten (2002) reported that the efficacy of glyphosate on *S. alterniflora* was affected more by a limited drying time (33% and 70% when applied at 7.2-8.4 kg ae/ha with < 7 hours and > 7 hours drying time respectively) than imazapyr efficacy (84% and 89% when applied at 1.68 kg ae/ha with < 7 hours and > 7 hours drying time respectively). Also when considering mechanical control the speed that the machine can achieve the treatment is also worth considering. Tilling, although the most effective of mechanical control against *S. alterniflora,* is a slow intervention to implement (~0.25 ha/hr reported by Patten 2004). Crushing is quicker than tilling (1-2hr/ha), but for more effective control two or more treatments are required in one year. Secondly, how expensive is the intervention? Mechanical control methods are costly as they require highly specialised equipment to be purchased, such as tracked vehicles. Tilling for example costs approximately £150,000 for the equipment and then personnel costs while undertaking control intervention, while crushing is considerable cheaper at ~£50,000 plus personnel costs. Herbicide costs are generally considerably cheaper especially when broadcast sprayed (~£300/ha) and herbicide is fast to apply (>100ha/day reported by Patten 2004).

6. REVIEWERS' CONCLUSIONS

6.1. Implications for Policy Makers and Practitioners

The available evidence (summarised in Table 3) suggests that to achieve a successful control programme, management interventions should be specifically targeted in regards to the species that are to be targeted. For example bio-control was found to be highly effective (92.5%) against *S. anglica*, but its effectiveness was remarkably reduced against *S. alterniflora* (18.4%).

Imazapyr and glyphosate were by far the most commonly used management intervention by practitioners. Imazapyr achieved 85.1% density reductions of *S. alterniflora* while not assessed against *S. anglica*, and glyphosate achieved 57.9% density reductions against *S. alterniflora* and 42.8% against *S. anglica*. The addition

of a surfactant/ wetting agent increased the effectiveness of both herbicides by an additional 8-12%. In addition, of these two herbicides, imazapyr provides greater control of *S. alterniflora* at lower concentrations with a smaller drying time required than glyphosate. The most effective herbicides against *S. anglica* were fenuron (88.2%) and aminote-T (75.8%), but both had small datasets and require further trials prior to extensive use.

Cutting alone is not an effective control intervention of *S. anglica*, producing, on average, an overall increase in stem density of 42.8%. However when cutting is combined with a smothering element such as industrial black plastic sheeting then this control methodology was highly significant, achieving declines of on average 98% (Table 3). In addition Hammond & Cooper (2003) reported that cutting and smothering was also the only management intervention which caused a decline in dry root weight. For the control of *S. alterniflora* both cutting only and cutting with glyphosate were effective at controlling densities (68% and 91% decline in density respectively).

The amount of available evidence for mechanical control interventions was limited and only in relation to *S. alterniflora* control. Of the three, winter tilling produced the most effective control intervention, followed by disking and finally crushing. Crushing effectiveness was affected by the substrate type, with greatest control achieved on sand and soft silt, and least effective on firm silts or those areas with well establish *Spartina* meadows. However tilling might be considered too costly for most *Spartina* management programmes, with the purchase of an amphibious tiller (~ £150,000), and is slow to implement (~0.25 ha/hr reported by Patten 2004). Crushing is less expensive than (~ £50,000), and in addition is quicker than tilling (1-2hr/ha), but for more effective control two or more treatments are required in one year (see Table 3).

Herbivory of *Spartina* spp. by ungulates (e.g. horses/cattle/deer) has been carried out for decades with little impact. However the use of a species such as *Prokelisia marginata* (a planthopper) as a classic biological control agent is still in its infancy and due to the limited number of datasets, further research into their use in controlling *S. alterniflora* and more promisingly against *S. anglica* should be investigated.

6.2. Implications for Further Research

There are numerous confounding variables which operate within an estuarine environment. The majority of experiments captured had an insufficient number of replicated to assess the impact of many of these sources of heterogeneity in a robust manner. The length of experimental follow-up should be standardised. The majority of practitioners aren't concerned whether a control intervention has worked within the first couple of months, instead require medium (10-12 months) and long term evaluations (2+ years) after control to assess whether a repeat treatment should be undertaken or a different control intervention be considered.

Further experimental evidence is required to fully establish the efficacy of a number of control interventions. These include the herbicides (paraquat, 2,2-DPA, aminote-T, fenuron, and diuron) cut and glyphosate, cut and smother and the herbivorous planthoppers (*Prokelisia* spp.). Experiments investigating the control of *S. townsendii*

and *S. patens* were sparse, further research into control of these species is required as outside of their native range they pose very similar problems to the more dominant *S. alterniflora* and *S. anglica*.

In addition to the above, the basic reporting of the site characteristics and methodology of experimental trials should be improved to include at the very least the month that the management intervention was undertaken. For herbicide trials the drying time before immersion is also an important variable for a practitioner to know, as small drying times significantly reduce the efficacy of glyphosate. For mechanical control the substrate of the site is also important as considerable affect to the effectiveness of the management intervention. If these potential reasons for heterogeneity are not reported within papers and/or reports then the practitioner could waste limited resources undertaking a management intervention that is not optimised to their particular situation.

7. POTENTIAL CONFLICTS OF INTEREST AND SOURCES OF SUPPORT

This project was undertaken by PDR as part of a NERC Ph.D. CASE studentship award in association with English Nature. No conflicts of interest are reported.

8. ACKNOWLEDGEMENTS

The authors would like to thank fellow members of the CEBC staff for advice. We would also like to thank Kim Patten for his advice and assistance given during the protocol development phase of the review and for providing additional data. In addition we would like to thank authors of the included articles for answering our queries regarding their experimental methodologies and datasets.

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Appendix One: Summary tables of the 46 included articles within the systematic review, allowing easy comparison of the methodology used and the general conclusions presented.

Article citation in text	Study type[1]	Subjects characteristics (species, age)	Intervention under investigation	Length of follow-up	Outcome measures	General conclusions of the study
Baldwin & Mendelssohn (1998)	RBD	*S. patens*	**Water Type** – **Salinity** (6ppt) or Fresh water **Water Level** - **Flooded** to 10cm of water above the soil surface. Non-Flooded, water level 10cm below soil surface. **Clipping** – Either clipped at soil surface or left uncut (this was used to simulate damage from herbivory And a **combination** of these treatments is also investigated	**1 year** (April 94 to April 95)	Above-ground live biomass (g)	Salinity and flooding when vegetation is clipped have a greater effect, suggesting that disturbance (clipping) catalyse vegetation change in response to environmental variables. The brackish marsh dominant *S. patens* was eliminated by a combination of flooding and disturbance (clipping) but not affected by salinity. There was no additional sprouting or recruitment by seed. The lack of a salinity effect on regrowth following disturbance under non-flooding conditions is presumably due to its greater physiological tolerance to salinity.
Bascand (1968)	Control Trial	*S. alterniflora* *S. townsendii* (dwarf form)	**Herbicides:** paraquat, 2,2-DPA, amitrole-T, fenuron (granules), bromacil, diuron On Spartina in sand or mud substrates	**1 & 10 months**	1) Average plant shoot counts per $^1/_4m^2$ 2) Average point quadrat hits per plot (50pts)	Tentatively, 2,2-DPA at 40lbs in one or split applications on both Spartina spp. in New Zealand irrespective of substrate is the most promising treatment.

Bertness *et al.* (1992)	RBD	*S. patens*	**Salinity** of water	**3 months**	Above-ground live biomass (g)	High marsh zonal dominants in New England (USA) marshes appear to be extremely sensitive to variation in salinity.
Bortolus *et al.* (2004)	Control Trial	*S. densiflora*	**Herbivory** (*Chasmagnathus granulate* – burrowing crab) **Cutting**	**40 days, 1 year & 2 years**	1) Standing Live Biomass (g m^2) 2) Reproductive stem height (cm) 3) Seed Density (ind. m^2) 4) Seed Viability (%)	Phenotypic expression of sexual reproductive structures of *S. densiflora* at Mar Chiquita (Argentina) is mediated by the burrowing crab. The combination of crabs and the cutting at surface level increased seed production by up to 721% compared uncut plots. Cut plants generated more seeds than uncut ones.
Brown *et al.* *(In Press)*	Control Trial (Factorial 3x3 designed)	*S. alterniflora*	**Salinity** – Three treatments 1) 3-5g, 2) 15-20g, 3) 35-38g **Water Level** – Three treatments 1) Drought = 20cm below soil surface at high tide. 2) Intermediate (between 20 – 10cm below soil level) 3) Flooding (3-5cm above soil level)	**28 days**	1) Shoot Dry Weight (g) 2) Root Dry Weight (g)	*S. alterniflora* performed well under all flooded conditions conditions regardless of the level of salinity, confirming its known salt tolerance capabilities. Survival rates for the flooded treatments were 100% under all salt regimes. Survival of the intermediate drought treatment for all salinities was 100%. Drought in combination with high salt decreased survival to 71%.
Castillo *et al.* (2005)	Unreported design ? Control Trial	*S. densiflora*	**Salinity** – five treatments. 1) 0.5 ppt 2) 10 ppt	**29 days**	1) Leaf elongation (cm day^{-1}) 2) Leaf water potential (Ψ_{leaf} Mpa)	Adult tussocks of the invasive cordgrass *S. densiflora* from the southwestern Iberian Peninsula show a high short-term

			3) 15 ppt 4) 20 ppt 5) 40 ppt			tolerance to salinity with high values in growth rates from 0.5 to 20ppt.
Daehler & Strong (1995)	Control Trial	*S. alterniflora*	**Herbivory** - combined (*Prokelisia marginata* & *Trigonotylus uhleri*) 1) Control (no herbivory) 2) Herbivory (@ 5 *P. marginata* & 0.25 *Trigonotylus uhleri* per plant)	**12 weeks**	1) Mean dry mass (g) 2) Mean number of shoots	The growth of the herbivore population is seasonal and correlated with the above-ground growth of *S. alterniflora*. Sparse herbivore populations in May and June increase to dense populations in September and October. One possible reason why high herbivore densities have so little effect on *S. alterniflora* is that the plant suffers no interspecific competition. It grows uncrowded, invading rich open mud. Under these conditions, stress due to light and nitrogen limitations are reduced in comparison with established stands. From the results of this study it is unlikely that herbivory by high densities of the sap-feeding insects: *P. marginata* and *T. uhleri* alone will be able to control the invasion of *S. alterniflora* in San Francisco Bay.
Daehler & Strong (1997)	Control trial	*S. alterniflora*	**Herbivory** (*Prokelisia marginata*)	**1 & 2 years**	1) Final mass of herbivory plants relative to non-herbivory plants	The low resistance of the Willapa Bay population of *S. alterniflora* to herbivory by *P. marginata* as observed in

					2) Mortality of plants	greenhouse studies, suggests that biocontrol may be an option worth exploring in Washington State.
Dethier & Hacker (2004)	Control Trial	*S. anglica*	**Herbicide** (5% Glyphosate and 1% surfactant R-11) **Crushing**	**1 year** (herbicide) **2 & 3 years** (crushing)	Proportional Decline (from one to the following year) & Grams or Number (per 0.25m^2) of: 1) Above ground biomass 2) Below ground biomass 3) Spike number	Skipping control efforts for even one year allows *S. anglica* to rebound quickly, negating the previous years' successes. Spraying early in the growing season (July) has the greatest effects in terms of reducing subsequent plant growth and seed production over the rest of that season. Spraying late in the season has almost no effect on fertility or growth during that year. Spraying at anytime of the year, had a significant negative effect on growth and seed production the following year.
Frid *et al.* (1999)	Control Trial	*S. anglica*	**Crushing** (Mechanical tracked vechile)	**3 years**	Density of *Spartina* (per m^2)	This study shows the effectiveness of a physical disturbance to control *Spartina* swards on tidal flats. The one-off disturbance by the tracked vehicle resulted in a reduction in the density of the *Spartina* swards over 3 years while having no measurable effect on the infauna.
Furbish & Albano (1994)	RBD	*S. alterniflora*	**Simulated Herbivory** – Feral Horses 1) Control 2) Simulated preferential grazing	**1.5 years**	1) Stems/m^2 2) % cover	Non-preferential grazing caused a decline in coverage for both grasses *S. alterniflora* & *Distichlis spicata*, but did not cause reduction of *S. alterniflora*

			(including trampling) of *S. alterniflora* only 3) Non-preferential grazing			counts. Preferential grazing diminishes *S. alterniflora* coverages and counts, while *D. spicata* coverage increase.
Garnett *et al.* (1992)	Control Trial	*S. anglica*	**Herbicide** Glyphosate (1800g a.e./ha)	**1 year**	1) Shoots/m^2 2) % reduction of shoot density 3) % overall control	The addition of Mixture B to Glyphosate (1800g a.e./ha) greatly increased its effect on *S. anglica*. It is essential to have maximum time before sea covers the treated areas, so applications should be made on neap tides, as shown by poor results at the Dyfi estuary (not reported in study). Treatments should be made when *Spartina* is reaching maturity and growing actively. Monitoring of invertebrate populations showed that use of Glyphosate alone only had minor effects, while the use of additive Mixture B caused short term decline of some species.

Goodman (1960)	Time series (before & after)	*S. townsendii*	**Cutting**	**1 year**	1) No. of inflorescences 2) No. of live shoots 3) Fresh weight (g) of live shoots 4) No. of dead shoots 5) Av. Height of live shoots 6) Av. Leaf No. per live shoot 7) Air-dry weight (g) of live rhizomes & roots	The chief effect of cutting healthy *Spartina* sward in September was to induce vigorous spring and summer bud growth. The developing shoots had few leaves, and were light in weight, none the less, they produced a crop of inflorescences almost as vigorous as that of the uncut sward.
Goranson (2004)	Time series	*S. alterniflora*	**Herbivory** *(Orphulella pelidna Orchelimum fidicinum)*	**72 hours**	Leaf area consumed mm^2	Both species preferred leaves from low-salt habitat. However *Orphulella* consumed greater amounts from low-salt habitats while *Orchelimum* consumed greater amounts from high-salt habitats.
Grevstad *et al.* (2003)	Control Trial (on 4 sites)	*S. alterniflora*	**Herbivory** (*Prokelisia marginata*)	**4 months**	1) Above ground (dry) biomass (g m^2) 2) Plant height (cm)	More than one year after the first release of *P. marginata* into Willapa Bay, the outlook for the biological control program against *S. alterniflora* is encouraging. Out host range tests indicate that this planthopper is highly specialised to a small group of closely related *Spartina* species. In addition to the target species, *P. marginata* will feed readily and complete its life cycle only on *S. foliosa* and *S. anglica*.

Hacker *et al.* (2001)	Time series	*S. anglica*	**Mowing & Herbicide** (Glyphosate)	**4 years**	% decline	Removal of *S. anglica* within Puget Sound has been modest but promising. Four years of removal treatments on half the invasion area has resulted in 26% decline or approximately 13% for the entire invasion. When habitat specific *S. anglica* removal success is considered, we find that high-salinity marsh have the greatest decline, low salinity marsh have the lowest decline.
Hammond (2001)	RBD (on 2 sites)	*S. anglica*	**Herbicide &/or Cutting &/or Smothering** (Dalapon & Glyphosate)	**1 & 2 years**	1) Stem Density (per $0.25m^2$) 2) Stem Height (cm)	It was noted that glyphosate caused visible browning of the *S. anglica* agg. leaves, but did not have effects on live stem density the following year. This suggests that glyphosate killed the above ground growth but did not penetrate or kill the *S. anglica* agg. root and rhizome system. Cutting had no additive effect when applied before herbicides in this study. The single-cut treatments produced the highest live stem density values at each site The smothering treatment had kill rates close to 100%. Smothering was also the only method in which dry root weight

						was lower or the same as the previous year.
Hammond & Cooper (2003)	RBD (on 2 sites)	*S. anglica*	**Herbicide &/or Cutting &/or Smothering** (Dalapon & Glyphosate)	**1 & 2 years**	% change in live stems	This study shows that when used in suitable conditions, Dalapon applied at a rate of 57kg/ha will cause over 95% reduction in live *S. anglica* stem density within the first year. Glyphosate was as ineffective with similar live *S. anglica* stem densities as the experimental control. Cutting had no additive effect when applied before Dalapon application. The single cut produced the highest live stem density values, therefore not assisting *Spartina* eradication. Smothering caused over 95% reductions in live *S. anglica* stem density. The experimental treatments failed to achieve 100% kill of *S. anglica*. Eradication would require repeat applications of eradication treatments, possible on many occasions.
Hannaford *et al.* (2006)	Site comparison (of 3 sites)	*S. anglica*	**Herbivory** (sika deer grazing – *Cervus Nippon*)	**Not reported**	% cover	Grazing appeared to have an impact on vegetation diversity and abundance but only at a localized level. S. anglica was much less abundant in grazed areas while other species such as *Salicornia ramosissima* and *Halimione portulacoides* were more abundant.

Hubbard (1970)	Control Trial	*S. anglica*	**Cutting**	**11 months**	1) Density (shoots/m^2) 2) Dry weight (g/m^2)	In a Spartina marsh subjected to repetitive cutting (5 cuts), growth during the following year was more uniform in height, denser and earlier in flowering than in control plots. The effects of treatment persisted for more than one summer.
Johnson & Foote (1997)	Control Trial	*S. patens*	**Herbivory** (nutria - *Myocastor* coypus)	**2 months to 3.5 years**	Aboveground biomass (g/m^2)	Nutria grazing was insufficient to reduce above-ground biomass of *S. patens*. The brackish leaves of this species is not the preferred food in saltmarshes. Nutria however did grub for roots and rhizomes over winter, leaving behind a mixed stand of dead, rootless stems and living intact stems. Root herbivory removes belowground biomass and subsequently thins the aboveground stand via stem mortality.
Kilbride (1995)	Control Trial	*S. alterniflora*	**Hebicide** (Rodeo®) Ariel & Ground Spraying	**11 months**	Density (stems/m^2)	This study found greater control with ground treatment compared to aerial application of Rodeo®. Aerial applications covered only the upper portion of the plant, while ground spraying covered more of the plant.
Lessmann *et al.* (1997)	Time series	*S. patens* & *S. alterniflora*	**Flooding**	**0 to 65 days**	1) Redox potential (E_h(mV)) 2) Leaf elongation (cm day^{-1})	Soil conditions were reduced to potentially stressful levels to decrease plant growth.

Linthurst (1979)	Control Trial	*S. alterniflora*	**Flooding & Aeration**	**5 months**	1) Density (stems/pot) 2) Aboveground biomass (g/pot) 3) Root biomass (g/pot)	Density values were not significantly different in the aerated systems but a decreased density in the unaerated system was observed. Both aboveground biomass and belowground biomass were enhanced by the aerated substrate treatment.
Linthurst & Seneca (1981)	RBD	*S. alterniflora*	**Salinity & Aeration**	**3 months**	1) Biomass (g/pot) 2) Density (stems/pot) 3) Mean Height (cm)	It is apparent that aeration and salinity are determinants for *S. alterniflora* growth. Salinity increases of $15^{0}/_{00}$ decreased biomass, density and mean height.
Lytle & Lytle (1998)	Control Trial	*S. alterniflora*	**Herbicide** (Atrazine)	**7, 14, 21, 28 & 35 days**	Mean shoot elongation (in cm)	Atrazine is a triazine herbicide that inhibits electron transport through photosystem II. It is also the most widely used herbicide in North America (data 1998). Study suggests that *S. alterniflora* is moderately resistant to atrazine.
Major *et al.* (2003)	Time series (before & after)	*S. alterniflora*	**Mowing** **Mowing & Herbicide** **Herbicide** (Ground application - Rodeo®) **Herbicide** (Aerial application - Rodeo®)	**1 year**	1) Mean % changes in stem density 2) Mean % change in max stem height	The results of aerial applications present a management dilemma. While it may be the only treatment for large Spartina infestations, especially those on very soft substrate, it appears not to be efficacious. Mowing appeared to be the least efficacious, the most labor intensive, and on soft mud sites, the most destructive to the habitat.

						Hand spraying, which was similar in efficacy to the mowing plus herbicide combination, appeared to be more efficient, but inconsistent between applicators.
Martin (2003)	Control Trial	*S. alterniflora*	**Herbivory** (cattle grazing)	**1 year**	1) Percent cover 2) Stem density (stem/0.5m^2) 3) Maximum height (in cm)	*S. alterniflora* heights were significantly greater for ungrazed versus grazed treatments in the edge, upper, and middle marsh elevation zones. *S. alterniflora* was also significantly taller in the ungrazed lower marsh (versus grazed).
Mendelssohn & McKee (1988)	Control Trial	*S. alterniflora*	**Flooding** (water-logged soil)	**1 year**	Aboveground biomass (g dry-weight/pot)	Transplantation of streamside *S. alterniflora* swards into more waterlogged and less productive inland marsh significantly reduced swards to their streamside controls.
Norman & Patten (1997)	Control Trial	*S. alterniflora*	**Hand-pulling, Mechanical (mowing), Herbicide (Rodeo/glyphosate)**	**4 to 11 months**	Percent kill	Hand-pulling achieved between 97%-100% control over 11 months. The most cost effective continuous mowing treatment involved a June and August mow.
Olmstead *et al.* (1997)	Control Trial	*S. alterniflora*	**Hervivory** (*Prokelisia dolus* – a planthopper)	**9 & 15 days**	1) Average number of new leaves/stem 2) Tiller elongation (cm) 3) Average number of dead leaves/stem	The available surface area of plant was reduced as a consequence of a decrease in culm and tiller elongation, production of new leaves, and an increase in leaf mortality associated with planthopper feeding.

Partridge & Wilson (1987)	Control Trial	*S. anglica*	**Salinity**	**1 year**	Live shoot dry weight as % of total shoot dry weight	*S. anglica* growth is suppressed by freshwater and by the highest salinities.
Patten (2004)	Site comparison	*S. alterniflora*	**Herbicide** (Glyphosate & Imazapyr) **Mechanical Control** (Crushing) **Crushing & Herbicide**	**1 year**	1) % *Spartina* free quadrats 2) % control 3) Stem density/0.25m^2	With the exceptions of tilling and impazapyr, no control method provided efficacy near the required to achieve eradication in a reasonable time frame of repeated years of control.
Patten (2006)	Site comparison	*S. alterniflora*	**Herbicide** (Glyphosate & Imazapyr)	**1 year**	Percent control compared to untreated area	Imazapyr was a more effective for controlling Spartina across the range of estuary conditions than glyphosate. Effective rates (ae/ha) for imazapyr were 1/10 those of glyphosate and took a shorter dry time then glysophate. The use of imazapyr is significantly more cost effective than glyphosate.
Patten (2002a)	RBD	*S. alterniflora*	**Herbicide** (Imazapyr, Glyphosate, Clethodim & Fluazifop-p)	**1 year**	1) Percent control 2) shoots/m^2	Clethodim was not very effective at controlling *S. alterniflora.* Control using imazapyr improved with increased rates of a.e/ha and was best with spray rates of greater than 0.94 l/ha. The effects of spray date on imazapyr efficacy were influenced by spray volume. Least effective dates were July and October. Because of concerns about toxicity to non-target aquatic organisms, the use of surfactant is an important issue. By showing similar control across surfactants, product

						selection can be made on the basis of risk reduction to non-target aquatic organisms.
Patten (2002b)	Control Trial across multiple sites	*S. alterniflora*	**Mechanical** (Tilling, Disking, Crushing & Combinations)	**6 months to 2 years**	1) Mean stem density/0.25m^2 2) Plant height (m)	Mechanical control can be effectively used to help in managing Spartina swards, however, manage and eradication are two different issues. All methods were problematic whether the coast of equipment or slow rate of treatment (<1-2ha/hr).
Pezeshki & Delaune (1997)	RBD	*S. patens*	**Salinity**	**3 months**	1) Number of shoots/per pot 2) Leaf area/per pot 3) Dry Weight/per pot	The observed responses of the study populations to elevated salinities could be partially explained in light of field observations which indicates that two populations are associated with high salinities characteristic of a brackish-saltmarsh zone, while the remaining population occupies the less saline environment of freshwater-brackish marsh zone.
Ranwell (1961)	Control Trial across two sites	*S. anglica*	**Herbivory** (Sheep)	**1 to 5 years**	1) Point quadrat hits 2) Total air dry wt (g)/per plot (0.01ha)	Sheep actually graze *Spartina* and apparently on the upper limits of salt-marsh sheep are often capable of slowing down the vegetative propagation of *Spartina* but they do not prevent the spreading of the species.
Reimold (1975)	Control Trial & Site comparison	*S. alterniflora*	**Herbivory** (Ungulates & simulated grazing)	**4 to 8 months**	1) Mean wet weight (g/m^2) 2) Mean dry weight (g/m^2)	Grazing of salt marshes by ungulates has a significant impact on the ecosystem. Primary production, detritus

	across three sites				3) Number of stems	production and invertebrate (crab) fauna are all reduced by grazing.
Seliskar (2003)	Control Trial	*S. patens*	**Herbivory** (feral horses)	**1 year**	1) Percent cover 2) Plant height (cm) 3) Leaf length (cm) 4) Stem diameter (mm) 5) Stem density (no. stem/m^2) 6) Aboveground shoot biomass (g/m^2) 7) Percent plants in flower 8) Root & rhizome biomass (g/m^2)	Grazing is detrimental to the growth and spread *S. patens*
Silliman & Zieman (2001)	Control Trial	*S. alterniflora*	**Herbivory** (*Littoraria irrorata* - periwinkle)	**4 months**	1) Stem biomass (g) 2) Stem height (cm) 3) No. of dead leaves/stem 4) Standing crop (g/m^2)	Based on studies results, two inferences made: (1) snails may facilitate microbial infection of live plant tissue (2) snails graze live Spartina even when standing-dead material is available.
Taylor & Burrows (1968a)	Control Trial	*S. townsendii*	**Herbicide** (Dalapon, Paraquat, Fenuron, Bromacil, Amitrole-T)	**5 months to 2 years**	1) Percentage kill 2) Living shoot height (cm)	Dalapon consistently gave the highest kills followed by the least regeneration, even at lower doses. High percentage kills were obtained with fenuron but these were followed by varying and sometimes comparatively large amounts of regrowth.
Taylor & Burrows (1968b)	Control Trial	*S. townsendii*	**Herbicide** (Paraquat)	**2 weeks to 6 months**	1) No. of leaves per main stem 2) No. of shoots per seedling 3) Percent plants killed	The results show that changes occur during the development of *Spartina* which render it less susceptible to paraquat with age.

Thom *et al.* (1997)	Control Trial	*S. alterniflora*	**Cutting & Burying** (Clipping)	**9 months**	Mean biomass (g dry wt)	Burial only was not different from untreated controls. Clipping and burial had the least regrowth. In two of the three replicates regrowth did not occur, with roots and rhizomes appearing dead.
Turner (1987)	Control Trial	*S. alterniflora*	**Herbivory (feral horses), Trampling, Burning Clipping & combinations of above treatments**	**2 to 4 months** (dependant on treatment)	1) Live biomass (g/m^2) 2) Standing dead (g/m^2) 3) Live rhizomes (g/m^2 to 10cm)	Burning seemed to be qualitatively different from both clipping and trampling. Plots which were burned exhibited a more dense growth of smaller (thinner) stems compared to unburned plots. Horses had a strong impact on large portions of the saltmarsh, however, grazing pressure was not uniform.
Wu *et al.* (1999)	Control Trial	*S. anglica*	**Herbivory** (*Prokelisia* - planthopper)	**5 to 10 months**	Percent mortality	The results of the study suggest that *Prokelisia* spp. Have the potential for the biological control of *S. anglica*. Within 4 months more than 90% of plants were killed in the high-density planthopper treatments. This mortality was in contrast to the low mortality of control plants with very low densities of planthoppers.

[1]RBD = Randomised Block design

Appendix Two – Raw data for figures 2(a-d).

S. alterniflora – Density				**S. anglica – Density**				**S. townsendii – Density**				**S. patens - Density**			
Management	n	mean	±sd	Management	n	mean	±sd	Management	n	mean	±sd	Management	n	mean	±sd
Herbicide															
Paraquat	6	0.527	0.167	Paraquat				Paraquat	10	0.616	0.327	Paraquat			
2,2-DPA	6	0.505	0.415	2,2-DPA				2,2-DPA	2	0.611	0.412	2,2-DPA			
Aminote-T	6	0.389	0.334	Aminote-T	13	0.758	0.241	Aminote-T	2	0.040	0.221	Aminote-T			
Fenuron	2	0.580	0.296	Fenuron	4	0.882	0.146	Fenuron	14	0.645	0.480	Fenuron			
Diuron	4	0.014	0.310	Diuron				Diuron				Diuron			
Glyphosate	31	0.579	0.336	Glyphosate	36	0.428	0.424	Glyphosate				Glyphosate			
Cut & glyphosate	6	0.911	0.117	Cut & glyphosate	4	-0.194	0.442	Cut & glyphosate				Cut & glyphosate			
Crush & glyphosate	4	0.779	0.177	Crush & glyphosate				Crush & glyphosate				Crush & glyphosate			
Imazapyr	37	0.851	0.192	Imazapyr				Imazapyr				Imazapyr			
Dalapon				Dalapon				Dalapon	4	0.975	0.05	Dalapon			
Cutting															
Cut only	6	0.681	0.354	Cut only	4	-0.428	0.487	Cut only	1	-0.147	0	Cut only			
Cut & smother				Cut & smother	4	0.979	0.030	Cut & smother				Cut & smother			
Cut & glyphosate	6	0.911	0.117	Cut & glyphosate	4	-0.194	0.442	Cut & glyphosate				Cut & glyphosate			
Mechanical															
All mechanical	21	0.733	0.283	All mechanical	2	0.731	0.380	All mechanical				All mechanical			
Only disking	4	0.895	0.083	Only disking				Only disking				Only disking			
Only crushing	13	0.612	0.298	Only crushing				Only crushing				Only crushing			
Only tilling	4	0.965	0.022	Only tilling				Only tilling				Only tilling			
Herbivory															
Ungulates	6	0.244	0.440	Ungulates				Ungulates				Ungulates	1	0.186	0
Prokelisia spp.	2	0.184	0.260	Prokelisia spp.	2	0.925	0.01	Prokelisia spp.				Prokelisia spp.			

Appendix Three: The methodological checklists used to extract the raw data and critically appraise each of the included studies

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Baldwin, A.H., Mendelssohn, I.A., 1998. Effects of salinity and water level on coastal marshes: An experimental test of disturbance as a catalyst for vegetation change. *Aquatic Botany* 61, 255-268.

Intervention: **Salinity, Water Level, & Clipping (to simulate damage by grazers)**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

In a well conducted study…..		***In this study this criterion is:***	
1.1	The study addresses an appropriate and clearly focused question.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.3	If randomised was an adequate concealment method used	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.4	The treatment and control groups are similar at the start of the trial	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.5	The only difference between groups is the treatment under investigation.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.6	All relevant outcomes are measured in a standard, valid and reliable way	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.7	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study? *Also indicate number in each arm of the study, at the time the study began, if given*	5 blocks of microcosms of marsh turf
2.2	What are the main characteristics of the population? *Include all relevant characteristics – e.g. age, sex, health status, location*	*S. patens*
2.3	If the treatment and control groups are **not** similar at the start of the trial give details of difference here	N/A
2.4	What intervention (treatment, procedure) is being investigated in this study?	Water Type – Saline (6ppt) or Fresh water Flooding – 10cm of water above the soil surface. Non-

<table>
<tr><td></td><td>List all interventions covered by the study.</td><td>Flooding – water level 10cm below soil surface.

Clipped – Either clipped at soil surface or left unclipped

A combination of these treatments is also investigated</td></tr>
<tr><td>2.5</td><td>What comparisons are made in the study?
Are comparisons made between treatments, or between treatment and control / no treatment group?</td><td>Both between treatments and between treatment and control is possible to extract</td></tr>
<tr><td>2.6</td><td>How long after intervention is the follow-up undertaken in the study?
Length of time subjects is followed, from beginning participation in the study. Note specified end points used to decide end of follow-up (e.g. death, complete cure). Note if follow-up period is shorter than originally planned and reason (if given).</td><td>Longest follow-up period is 1 year</td></tr>
<tr><td>2.7</td><td>What outcome measure(s) are used in the study?
List all outcomes that are used to assess effectiveness of the interventions used.</td><td>Above-ground live biomass (g) of S. patens</td></tr>
<tr><td>2.8</td><td>What size of effect is identified in the study?
List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.</td><td>
<table>
<tr><td colspan="4">Un-Clipped</td><td colspan="4">Clipped</td></tr>
<tr><td colspan="2">Non-flooded</td><td colspan="2">Flooded</td><td colspan="2">Non-flooded</td><td colspan="2">Flooded</td></tr>
<tr><td>Fresh (F)</td><td>Salt (S)</td><td>F</td><td>S</td><td>F</td><td>S</td><td>F</td><td>S</td></tr>
<tr><td>14.07</td><td>4.32</td><td>10.71</td><td>11.24</td><td>6.04</td><td>6.20</td><td>0</td><td>0</td></tr>
</table>
</td></tr>
<tr><td>2.9</td><td>How was this study funded?
List all sources of funding quoted in the article.</td><td>National Science Foundation (USA)</td></tr>
<tr><td>2.10</td><td>Does this study help to answer your key question?
Summarise the main conclusions of the study and indicate how it relates to the key question.</td><td>Salinity and flooding when vegetation is clipped have a greater effect, suggesting that disturbance (clipped) catalyse vegetation change in response to environmental variables.
The brackish marsh dominant S. patens was eliminated by a combination of flooding and disturbance (clipped) but not affected by salinity. There was no additional sprouting or recruitment by seed.

The lack of a salinity effect on regrowth following disturbance under non-flooding conditions is presumably due to its greater physiological tolerance to salinity.</td></tr>
</table>

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Bascand, L.D., 1968. The control of Spartina species, *Proc. 26th N Z Weed Pest Control Conf* pp.108-113.

Intervention: **Chemical**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

	In a well conducted study…..	***In this study this criterion is:***	
1.1	The study addresses an appropriate and clearly focused question.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.3	If randomised was an adequate concealment method used	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.4	The treatment and control groups are similar at the start of the trial	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.5	The only difference between groups is the treatment under investigation.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.6	All relevant outcomes are measured in a standard, valid and reliable way	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.7	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study? *Also indicate number in each arm of the study, at the time the study began, if given*	Experiment 1: two replicates of a 4x2x2 layout in which substrates were confounded with tidal zones Experiment 2: 5x2 split plot layout
2.2	What are the main characteristics of the population? *Include all relevant characteristics – e.g. age, sex, health status, location*	*S. alterniflora* *S. townsendii* (dwarf form)
2.3	If the treatment and control groups are **not** similar at the start of the trial give details of difference here	N/A

<table>
<tr><td>2.4</td><td>What intervention (treatment, procedure) is being investigated in this study?
List all interventions covered by the study.

Please Note: Rates are in <u>lb/acre</u> these will be converted to <u>kg/ha</u> when reporting results in the reviews text.</td><td>
<table>
<tr><td colspan="3">Trial 1: Species x Substrate, Rate of Herbicide applied to S. alterniflora & S. townsendii</td></tr>
<tr><td colspan="2">Chemical</td><td>Rate (lb/acre)</td></tr>
<tr><td colspan="2">paraquat</td><td>2</td></tr>
<tr><td colspan="2">2,2-DPA</td><td>37</td></tr>
<tr><td colspan="2">amitrole-T</td><td>4</td></tr>
<tr><td colspan="2">fenuron (granules) 2 applications of</td><td>12.5 ea.</td></tr>
<tr><td colspan="3">Trial 2: Rates of herbicide on S. alterniflora in mud with average height of 8.9in (22.6cm)</td></tr>
<tr><td>Chemical</td><td colspan="2">Rates (lb/acre)</td></tr>
<tr><td></td><td>Low</td><td>High</td></tr>
<tr><td>paraquat</td><td>1</td><td>3</td></tr>
<tr><td>2,2-DPA</td><td>18.5</td><td>55.5</td></tr>
<tr><td>amitrole-T</td><td>2</td><td>6</td></tr>
<tr><td>bromacil</td><td>10.6</td><td>32</td></tr>
<tr><td>diuron</td><td>20</td><td>60</td></tr>
</table>
</td></tr>
<tr><td>2.5</td><td>What comparisons are made in the study?
Are comparisons made between treatments, or between treatment and control / no treatment group?</td><td>Trial 1: Species x substrate x herbicide

Trial 2: Rate of application of herbicide</td></tr>
<tr><td>2.6</td><td>How long after intervention is the follow-up undertaken in the study?
Length of time subjects is followed, from beginning participation in the study. Note specified end points used to decide end of follow-up (e.g. death, complete cure).</td><td>Follow-up time either one or ten months in both trials.</td></tr>
<tr><td>2.7</td><td>What outcome measure(s) are used in the study?
List all outcomes that are used to assess effectiveness of the interventions used.</td><td>Average plant shoot counts per $^1/_4m^2$

Average point quadrat hits per plot (50pts)</td></tr>
<tr><td>2.8</td><td>What size of effect is identified in the study?
List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.</td><td>
Trial 1: Species x substrate x herbicide.
Average plant shoot counts per $^1/_4m^2$ on S. alterniflora
<table>
<tr><td>Treatment</td><td colspan="4">On mud</td><td colspan="4">On sand</td></tr>
<tr><td></td><td colspan="2">Alive</td><td colspan="2">Dead</td><td colspan="2">Alive</td><td colspan="2">Dead</td></tr>
<tr><td>paraquat</td><td>38.5</td><td>52.8</td><td>26.0</td><td>21.8</td><td>11.8</td><td>16.5</td><td>22.8</td><td>24.3</td></tr>
<tr><td>2,2-DPA</td><td>73.5</td><td>28.0</td><td>4.8</td><td>31.5</td><td>21.0</td><td>7.3</td><td>5.8</td><td>30.3</td></tr>
<tr><td>amitrole-T</td><td>59.0</td><td>28.8</td><td>10.0</td><td>44.8</td><td>15.5</td><td>15.3</td><td>7.5</td><td>24.3</td></tr>
</table>
</td></tr>
</table>

		fenuron	59.5	12.3	6.2	39.0	24.2	16.5	5.5	22.0
		Control	79.5	92.5	2.0	6.8	53.5	44.5	-	10.0
		Sampling Date	Apr 11	Sept 28	Apr 11	Sept 28	Apr 11	Sept 28	Apr 11	Sept 28

Trial 1: Species x substrate x herbicide.

Average point quadrat hits per plot (50pts) on *S. townsendii*

Treatment	On mud				On sand			
	Alive		Dead		Alive		Dead	
paraquat	4.5	9.5	18.5	1.5	12.0	8.5	14.0	1.0
2,2-DPA	9.5	-	17.5	4.0	22.5	2.5	11.5	12.5
amitrole-T	23.0	9.0	3.5	3.0	29.5	11.5	9.5	1.5
fenuron	17.0	9.5	8.5	1.5	35.5	21.0	9.0	1.0
Control	20.5	10.5	10.0	0.5	26.5	15.0	10.0	1.0
Sampling Date	Apr 5	Oct 12	Apr 5	Oct 12	Apr 5	Oct 12	Apr 5	Oct 12

Trial 2: Rates of application of herbicide.

Average plant shoot counts per $^1/_4m^2$ on *S. alterniflora*

	High rates				Low rates			
	Alive		Dead		Alive		Dead	
paraquat	25.5	24.3	61.7	58.3	38.5	62.3	35.0	34.5
2,2-DPA	44.8	1.5	32.2	57.5	81.5	16.8	27.2	75.8
amitrole-T	45.2	23.5	70.2	92.5	86.2	53.3	43.2	62.0
bromacil	64.2	21.5	49.2	58.0	59.8	28.5	50.5	65.8
diuron	72.5	47.0	21.8	35.8	93.8	85.3	31.5	28.3
control	71.0	82.5	11.0	18.0	71.0	82.5	11.0	18.0
Sampling Date	Apr 18	Sept 27	Apr 18	Sept 27	Apr 18	Sept 27	Apr 18	Sept 27

2.9	How was this study funded? *List all sources of funding quoted in the article.*	No details of funding given
2.10	Does this study help to answer your key question? *Summarise the main conclusions of the study and indicate how it relates to the key question.*	Tentatively, 2,2-DPA at 40lbs in one or split applications on both Spartina spp. in New Zealand irrespective of substrate is the most promising treatment.

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Bertness, M.D., Gough, L., Shumway, S.W., 1992. Salt Tolerances and The Distribution of Fugitive Salt Marsh Plants. Ecology 73, 1842-1851

Intervention: **Salinity**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

	In a well conducted study…..	***In this study this criterion is:***
1.1	The study addresses an appropriate and clearly focused question.	Well covered / Adequately addressed / Poorly addressed / Not addressed / Not reported / Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered / Adequately addressed / Poorly addressed / Not addressed / Not reported / Not applicable
1.3	If randomised was an adequate concealment method used	Not reported
1.4	The treatment and control groups are similar at the start of the trial	Well covered / Adequately addressed / Poorly addressed / Not addressed / Not reported / Not applicable
1.5	The only difference between groups is the treatment under investigation.	Well covered
1.6	All relevant outcomes are measured in a standard, valid and reliable way	Well covered / Adequately addressed / Poorly addressed / Not addressed / Not reported / Not applicable
1.7	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Not applicable

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study? *Also indicate number in each arm of the study, at the time the study began, if given.*	Control Trial
2.2	What are the main characteristics of the population? *Include all relevant characteristics – e.g. age, sex, health status, location*	*S. patens*
2.3	If the treatment and control groups are **not** similar at the start of the trial give details of difference here	N/A
2.4	What intervention (treatment, procedure) is being investigated in this study?	Salinity of water (g/kg)

<table>
<tr><td></td><td>List all interventions covered by the study.</td><td></td></tr>
<tr><td>2.5</td><td>What comparisons are made in the study?
Are comparisons made between treatments, or between treatment and control / no treatment group?</td><td>The biomass of Spartina plants at differing salinities (mean ± 1se of 10 replicates)

Control of the trial is not listed but could be taken as the value for salinity treatment 0g/kg</td></tr>
<tr><td>2.6</td><td>How long after intervention is the follow-up undertaken in the study?
Length of time subjects is followed, from beginning participation in the study. Note specified end points used to decide end of follow-up (e.g. death, complete cure). Note if follow-up period is shorter than originally planned and reason (if given).</td><td>3 months</td></tr>
<tr><td>2.7</td><td>What outcome measure(s) are used in the study?
List all outcomes that are used to assess effectiveness of the interventions used.</td><td>Dry biomass aboveground (g)

Salinity of water (g/kg)</td></tr>
<tr><td>2.8</td><td>What size of effect is identified in the study?
List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.</td><td>Dry biomass (mean g ± 1se) 3 months follow-up after salinity treatments in greenhouse grown S. patens
<table><tr><td>Salinity</td><td>0</td><td>15</td><td>30</td></tr><tr><td>Dry biomass</td><td>8.5 ± 1.5</td><td>6.75 ± 1.0</td><td>2.5 ± 1.0</td></tr></table></td></tr>
<tr><td>2.9</td><td>How was this study funded?
List all sources of funding quoted in the article.</td><td>National Science Foundation (USA) – Ecology Programme</td></tr>
<tr><td>2.10</td><td>Does this study help to answer your key question?
Summarise the main conclusions of the study and indicate how it relates to the key question.</td><td>High marsh zonal dominants in New England (USA) marshes appear to be extremely sensitive to variation in salinity.</td></tr>
</table>

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Bortolus, A., Laterra, P., Iribarne, O., 2004. Crab-mediated phenotypic changes in Spartina densiflora Brong. Estuarine, Coastal and Shelf Science 59, 97-107.

Intervention: **Herbivore (*Chasmagnathus granulate* – burrowing crab) & Cutting**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

	In a well conducted study…..	***In this study this criterion is:***
1.1	The study addresses an appropriate and clearly focused question.	Well covered / Adequately addressed / Poorly addressed / Not addressed / Not reported / Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered / Adequately addressed / Poorly addressed / Not addressed / Not reported / **Not applicable**
1.3	If randomised was an adequate concealment method used	Well covered / Adequately addressed / Poorly addressed / Not addressed / Not reported / **Not applicable**
1.4	The treatment and control groups are similar at the start of the trial	**Well covered** / Adequately addressed / Poorly addressed / Not addressed / Not reported / Not applicable
1.5	The only difference between groups is the treatment under investigation.	**Well covered** / Adequately addressed / Poorly addressed / Not addressed / Not reported / Not applicable
1.6	All relevant outcomes are measured in a standard, valid and reliable way	**Well covered** / Adequately addressed / Poorly addressed / Not addressed / Not reported / Not applicable
1.7	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Well covered / Adequately addressed / Poorly addressed / Not addressed / Not reported / **Not applicable**

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study? *Also indicate number in each arm of the study, at the time the study began, if given.*	Control trial using cages to exclude/increase and control levels of crabs. Treatments were replicated four times each. Experiment was repeated also cutting all plants at the start.
2.2	What are the main characteristics of the population? *Include all relevant characteristics – e.g. age, sex, health status, location*	*S. densiflora*
2.3	If the treatment and control groups are **not** similar at the start of the trial give details of difference here	N/A

<table>
<tr><td>2.4</td><td>What intervention (treatment, procedure) is being investigated in this study?
List all interventions covered by the study.</td><td>The presence of natural levels (control) increased and excluded densities of crabs. The effect of cutting in addition to herbivory.</td></tr>
<tr><td>2.5</td><td>What comparisons are made in the study?
Are comparisons made between treatments, or between treatment and control / no treatment group?</td><td>Clipped v Unclipped (Excluded/Control/Increase crabs)</td></tr>
<tr><td>2.6</td><td>How long after intervention is the follow-up undertaken in the study?
Length of time subjects is followed, from beginning participation in the study. Note specified end points used to decide end of follow-up (e.g. death, complete cure). Note if follow-up period is shorter than originally planned and reason (if given).</td><td>Two year follow-up</td></tr>
<tr><td>2.7</td><td>What outcome measure(s) are used in the study?
List all outcomes that are used to assess effectiveness of the interventions used.</td><td>Standing Live Biomass (g m2)
Reproductive stem height (cm)
Seed Density (ind. m2)
Seed Viability (%)</td></tr>
<tr><td>2.8</td><td>What size of effect is identified in the study?
List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.</td><td>Differences in mean ± s.e. of the following measures of characteristics of S. densiflora
<table>
<tr><td>Crabs</td><td colspan="2">Excluded</td><td colspan="2">Control</td><td colspan="2">Inclusion</td></tr>
<tr><td></td><td>Uncut</td><td>Cut</td><td>Uncut</td><td>Cut</td><td>Uncut</td><td>Uncut</td></tr>
<tr><td>Stem Height (cm)</td><td>56 ± 2</td><td>46 ± 4</td><td>57 ± 1</td><td>46 ± 3</td><td>62 ± 2</td><td>60 ± 5</td></tr>
<tr><td>Seed Density (ind m^2)</td><td>670 ± 500</td><td>1800 ± 175</td><td>350 ± 50</td><td>670 ± 100</td><td>750 ± 175</td><td>2500 ± 600</td></tr>
<tr><td>Seed Viability (%)</td><td>5</td><td>15</td><td>0</td><td>18</td><td>7</td><td>28</td></tr>
<tr><td>Standing Live Biomass (g m^2) @ 40 days</td><td>190 ± 40</td><td>320 ± 150</td><td>160 ± 40</td><td>120 ± 10</td><td>80 ± 10</td><td>80 ± 5</td></tr>
<tr><td>Standing Live Biomass (g m^2) @ 1 year</td><td>680 ± 200</td><td>960 ± 160</td><td>840 ± 320</td><td>480 ± 40</td><td>280 ± 40</td><td>400 ± 80</td></tr>
<tr><td>Standing Live Biomass (g m^2) @ 2 year</td><td>240 ± 40</td><td>280 ± 80</td><td>200 ± 80</td><td>270 ± 120</td><td>250 ± 40</td><td>200 ± 40</td></tr>
</table></td></tr>
<tr><td>2.9</td><td>How was this study funded?
List all sources of funding quoted in the article.</td><td>CIC, CONICET, Fundacion Antorchas, IFS, Mellon Foundation, Universidad Nacional de Mar del Plata, The National Geographic Society.</td></tr>
<tr><td>2.10</td><td>Does this study help to answer your key question?
Summarise the main conclusions of the study and indicate how it relates to the key question.</td><td>Phenotypic expression of sexual reproductive structures of S. densiflora at Mar Chiquita (Argentina) is mediated by the burrowing crab.

The combination of crabs and the cutting at surface level increased seed production by up to 721% compared uncut plots.

Cut plants generated more seeds than uncut ones.</td></tr>
</table>

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Brown, C.E., Pezeshki, S.R., DeLaune, R.D., In Press. The effects of salinity and soil drying on nutrient uptake and growth of Spartina alterniflora in a simulated tidal system. Environmental and Experimental Botany In Press, Corrected Proof.

Intervention: **Salinity & Water Levels**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

In a well conducted study…..		***In this study this criterion is:***	
1.1	The study addresses an appropriate and clearly focused question.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.3	If randomised was an adequate concealment method used	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.4	The treatment and control groups are similar at the start of the trial	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.5	The only difference between groups is the treatment under investigation.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.6	All relevant outcomes are measured in a standard, valid and reliable way	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.7	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study? *Also indicate number in each arm of the study, at the time the study began, if given.*	Factorial designed 3 by 3 control trial
2.2	What are the main characteristics of the population? *Include all relevant characteristics – e.g. age, sex, health status, location*	*S. alterniflora*
2.3	If the treatment and control groups are **not** similar at the start of the trial give details of difference here	N/A
2.4	What intervention (treatment, procedure) is being investigated in this study?	**Salinity** – Three treatments 1) L = 3-5g, 2) M = 15-20g,

<table>
<tr><td></td><td>List all interventions covered by the study.</td><td>3) H = 35-38g
Water Level – Three treatments
1) Drought = 20cm below soil surface at high tide.
2) Intermediate (between 20 – 10cm below soil level)
3) Flooding (3-5cm above soil level)</td></tr>
<tr><td>2.5</td><td>What comparisons are made in the study?
Are comparisons made between treatments, or between treatment and control / no treatment group?</td><td>No control plot, comparisons are made between each of the treatment plots.</td></tr>
<tr><td>2.6</td><td>How long after intervention is the follow-up undertaken in the study?
Length of time subjects is followed, from beginning participation in the study. Note specified end points used to decide end of follow-up (e.g. death, complete cure). Note if follow-up period is shorter than originally planned and reason (if given).</td><td>28 days</td></tr>
<tr><td>2.7</td><td>What outcome measure(s) are used in the study?
List all outcomes that are used to assess effectiveness of the interventions used.</td><td>Shoot Dry Weight (g)
Root Dry Weight (g)</td></tr>
<tr><td>2.8</td><td>What size of effect is identified in the study?
List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.</td><td>Shoot and root biomass components (g dry weight) for the combination of treatments
<table>
<tr><td></td><td>Shoot</td><td>Root</td></tr>
<tr><td>LF</td><td>8.7 ± 0.7</td><td>4.2 ± 0.3</td></tr>
<tr><td>LI</td><td>4.4 ± 1.0</td><td>2.6 ± 0.9</td></tr>
<tr><td>LD</td><td>4.0 ± 1.0</td><td>2.0 ± 0.4</td></tr>
<tr><td>MF</td><td>7.0 ± 0.7</td><td>4.4 ± 0.4</td></tr>
<tr><td>MI</td><td>3.3 ± 1.0</td><td>2.8 ± 0.6</td></tr>
<tr><td>MD</td><td>2.0 ± 0.4</td><td>1.0 ± 0.2</td></tr>
<tr><td>HF</td><td>3.1 ± 0.7</td><td>2.4 ± 0.8</td></tr>
<tr><td>HI</td><td>1.7 ± 0.7</td><td>1.9 ± 0.8</td></tr>
<tr><td>HD</td><td>1.0 ± 0.4</td><td>1.4 ± 0.2</td></tr>
</table></td></tr>
<tr><td>2.9</td><td>How was this study funded?
List all sources of funding quoted in the article.</td><td>Not reported</td></tr>
<tr><td>2.10</td><td>Does this study help to answer your key question?
Summarise the main conclusions of the study and indicate how it relates to the key question.</td><td>S. alterniflora performed well under all flooded conditions regardless of the level of salinity, confirming its known salt tolerance capabilities.
Survival rates for the flooded treatments were 100% under all salt regimes.
Survival of the intermediate drought treatment for all salinities was 100%.
Drought in combination with high salt decreased survival to 71%.</td></tr>
</table>

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Castillo, J.M., Rubio-Casal, A.E., Redondo, S., Alvarez-Lopez, A.A., Luque, T., Luque, C., Nieva, F.J., Castellanos, E.M., Figueroa, M.E., 2005. Short-term responses to salinity of an invasive cordgrass. Biological Invasions 7, 29-35.

Intervention: **Salinity**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

	In a well conducted study…..	***In this study this criterion is:***
1.1	The study addresses an appropriate and clearly focused question.	Well covered / Adequately addressed / Poorly addressed / Not addressed / Not reported / Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Adequately addressed / Not reported
1.3	If randomised was an adequate concealment method used	Adequately addressed / Not reported
1.4	The treatment and control groups are similar at the start of the trial	Adequately addressed
1.5	The only difference between groups is the treatment under investigation.	Adequately addressed
1.6	All relevant outcomes are measured in a standard, valid and reliable way	Well covered
1.7	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Not applicable

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study? *Also indicate number in each arm of the study, at the time the study began, if given.*	Greenhouse experiment in controlled temperatures of 21-25^{o}C with fixed photoperiod of 15hrs. No details of design other than 5 replicates for each treatment undertaken.
2.2	What are the main characteristics of the population? *Include all relevant characteristics – e.g. age, sex, health status, location*	*S. densiflora* adult tussocks from Odiel river salt marsh, (south-western Iberian Peninsula) low marsh.
2.3	If the treatment and control groups are **not** similar at the start of the trial give details of difference here	N/A

2.4	What intervention (treatment, procedure) is being investigated in this study? *List all interventions covered by the study.*	**Salinity** – five treatments. 1) 0.5 ppt, 2) 10 ppt, 3) 15 ppt, 4) 20 ppt, 5) 40 ppt
2.5	What comparisons are made in the study? *Are comparisons made between treatments, or between treatment and control / no treatment group?*	No control plot, comparisons are made between each of the treatment plots.
2.6	How long after intervention is the follow-up undertaken in the study? *Length of time subjects is followed, from beginning participation in the study.*	29 days
2.7	What outcome measure(s) are used in the study? *List all outcomes that are used to assess effectiveness of the interventions used.*	Leaf elongation (cm day^{-1}) Leaf water potential (Ψ_{leaf} Mpa)
2.8	What size of effect is identified in the study? *List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.*	Leaf water potential (Ψ_{leaf}) & elongation (cm day^{-1}) in relation to salinity in S. densiflora

Salinity (ppt)	(Ψ_{leaf} Mpa)	elongation (cm day^{-1})
0.5	-0.6 ± 0.1	2.55 ± 0.15
10	-1.0 ± 0.2	2.45 ± 0.30
15	-1.3 ± 0.4	2.50 ± 0.05
20	-1.3 ± 0.2	2.30 ± 0.30
40	-3.5 ± 0.3	1.00 ± 0.15

2.9	How was this study funded? *List all sources of funding quoted in the article.*	DIGICYT grant
2.10	Does this study help to answer your key question? *Summarise the main conclusions of the study and indicate how it relates to the key question.*	Adult tussocks of the invasive cordgrass *S. densiflora* from the south-western Iberian Peninsula show a high short-term tolerance to salinity with high values in growth rates from 0.5 to 20ppt.

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Daehler, C.C., Strong, D.R., 1995. Impact of High Herbivore Densities on Introduced Smooth Cordgrass, Spartina-Alterniflora, Invading San-Francisco Bay, California. Estuaries 18, 409-417.

Intervention: **Herbivore (*Prokelisia marginata* – a Planthopper & *Trigonotylus uhleri* – a Mirid bug)**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

In a well conducted study…..		***In this study this criterion is:***
1.1	The study addresses an appropriate and clearly focused question.	Well covered / Adequately addressed / Poorly addressed / Not addressed / Not reported / Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Adequately addressed / Well covered / Poorly addressed / Not addressed / Not reported / Not applicable

1.3	If randomised was an adequate concealment method used	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable
1.4	The treatment and control groups are similar at the start of the trial	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable
1.5	The only difference between groups is the treatment under investigation.	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable
1.6	All relevant outcomes are measured in a standard, valid and reliable way	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable
1.7	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study? *Also indicate number in each arm of the study, at the time the study began, if given.*	Greenhouse experiment with four trays of 30 pots. The position of each pot within the tray was randomised. Initial treatments of insects were 5 *P. marginata* and 0.25 *T. uhleri* per plant. One tray was left untreated as a control. Position of trays were rotated bi-weekly to minimise lighting effects.
2.2	What are the main characteristics of the population? *Include all relevant characteristics – e.g. age, sex, health status, location*	*S. alterniflora* Herbivores *(P. marginata* and *T. uhleri*)
2.3	If the treatment and control groups are **not** similar at the start of the trial give details of difference here	N/A
2.4	What intervention (treatment, procedure) is being investigated in this study? *List all interventions covered by the study.*	Herbivory at 5 *P. marginata* and 0.25 *T. uhleri* per plant No herbivory – control tray
2.5	What comparisons are made in the study? *Are comparisons made between treatments, or between treatment and control / no treatment group?*	Herbivory on three trays (30 plants each) and control tray of (30 plants)
2.6	How long after intervention is the follow-up undertaken in the study? *Length of time subjects is followed, from beginning participation in the study. Note specified end points used to decide end of follow-up (e.g. death, complete cure). Note if follow-up period is shorter than originally planned and reason (if given).*	12 weeks
2.7	What outcome measure(s) are used in the study? *List all outcomes that are used to assess effectiveness of the interventions used.*	1) Mean dry mass (g) 2) Mean number of shoots
2.8	What size of effect is identified in the study? *List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p*	Mean dry mass (g) and number of shoots of *S. alterniflora* under herbivory and control treatments (± 95% confidence intervals given)

	values and any confidence intervals that are provided.		Dry mass (g)	N$^{o.}$ of shoots
		Control	2.75 ± 0.4	7.0 ± 0.70
		Herbivory (tray 1)	2.70 ± 0.5	5.0 ± 0.56
		Herbivory (tray 2)	2.24 ± 0.5	6.1 ± 0.70
		Herbivory (tray 3)	2.0 ± 0.4	4.4 ± 0.56
2.9	How was this study funded? *List all sources of funding quoted in the article.*	State of California Department of Water Resources, University Academic Research Involvement Program		
2.10	Does this study help to answer your key question? *Summarise the main conclusions of the study and indicate how it relates to the key question.*	The growth of the herbivore population is seasonal and correlated with the above-ground growth of *S. alterniflora*. Sparse herbivore populations in May and June increase to dense populations in September and October. One possible reason why high herbivore densities have so little effect on *S. alterniflora* is that the plant suffers no interspecific competition. It grows uncrowded, invading rich open mud. Under these conditions, stress due to light and nitrogen limitations are reduced in comparison with established stands. Herbivory can be most effective under stressed conditions like high plant density. From the results of this study it is unlikely that herbivory by high densities of the sap-feeding insects: *P. marginata* and *T. uhleri* alone will be able to control the invasion of *S. alterniflora* in San Francisco Bay.		

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Daehler, C.C., Strong, D.R., 1997. Reduced herbivore resistance in introduced smooth cordgrass (Spartina alterniflora) after a century of herbivore-free growth. Oecologia 110, 99-108.

Intervention: **Herbivore (*Prokelisia marginata* – a sap-feeding Planthopper)**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

In a well conducted study…..		***In this study this criterion is:***	
1.1	The study addresses an appropriate and clearly focused question.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.3	If randomised was an adequate concealment method used	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.4	The treatment and control groups are similar at the start of the trial	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable

1.5	The only difference between groups is the treatment under investigation.	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable
1.6	All relevant outcomes are measured in a standard, valid and reliable way	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable
1.7	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study? *Also indicate number in each arm of the study, at the time the study began, if given*	Seeds collected from Willapa Bay, Washington and San Francisco Bay. Five seedlings from each site (randomly chosen from 100 collected) were vegetatively propagated in a greenhouse. Each was divided the following year to give 12 clone replicates of 3-5 shoots
2.2	What are the main characteristics of the population? *Include all relevant characteristics – e.g. age, sex, health status, location*	*S. alterniflora* grown from seed all similar age and matched for height and root biomass. Adult *P. marginata* used as the herbivore.
2.3	If the treatment and control groups are **not** similar at the start of the trial give details of difference here	Seeds from the various treatment groups are from differing sites to show genetic effect of growing without a natural herbivore.
2.4	What intervention (treatment, procedure) is being investigated in this study? *List all interventions covered by the study.*	Herbivory by adult *P. marginata* @ average of 10 per plant.
2.5	What comparisons are made in the study? *Are comparisons made between treatments, or between treatment and control / no treatment group?*	Depending upon the experiment comparisons are made either between herbivory & control or between herbivory treatments & site of seed collection (no control used).
2.6	How long after intervention is the follow-up undertaken in the study? *Length of time subjects is followed, from beginning participation in the study. Note specified end points used to decide end of follow-up (e.g. death, complete cure). Note if follow-up period is shorter than originally planned and reason (if given).*	1 & 2 years
2.7	What outcome measure(s) are used in the study? *List all outcomes that are used to assess effectiveness of the interventions used.*	1) Final mass of herbivory plants relative to non-herbivory plants x 100 2) Mortality of *S. alterniflora*
2.8	What size of effect is identified in the study? *List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.*	Final mass of herbivory plants relative to non-herbivory plants x 100 averaged across the clones (± 1sd) after 2 years

n=5	SF bay	Willapa bay	Maryland
Measure	83.5 ± 20.3	12.7 ± 10.1	129 ± 17.4

Mortality of *S. alterniflora* (as %)

			Herbivory	Control
		San Francisco	0 ± 0	0 ± 0
		Willapa Bay	36.8 ± 39.7	3.4 ± 7.6
2.9	How was this study funded? *List all sources of funding quoted in the article, whether Government, voluntary sector, or industry.*	California Sea Grant & State of California Department of Water Resources, University Academic Research Involvement Program		
2.10	Does this study help to answer your key question? *Summarise the main conclusions of the study and indicate how it relates to the key question.*	Herbivore resistance refers to any genetically controlled quality that results in one population (or other unit of interest) being less damaged by a particular herbivore than another. Based on above-ground biomass measurements, the Willapa Bay population was less resistant to herbivory than the San Francisco and Maryland populations. The higher sensitivity of the Willapa Bay population to herbivory could be the result from of a founder effect, genetic drift, natural selection in Willapa Bay, or any combination of these factors. The low resistance of the Willapa Bay population of *S. alterniflora* to herbivory by *P. marginata* as observed in greenhouse studies suggests that biocontrol may be an option worth exploring in Washington State.		

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Dethier, M.N., Hacker, S.D., 2004. Improving management practices for invasive cordgrass in the Pacific Northwest: A case study of *Spartina anglica*, Sea Grant, Washington.

Intervention: **Herbicide & Crushing experiments**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

In a well conducted study…..		***In this study this criterion is:***	
1.1	The study addresses an appropriate and clearly focused question.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.3	If randomised was an adequate concealment method used	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.4	The treatment and control groups are similar at the start of the trial	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.5	The only difference between groups is the treatment under investigation.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable

1.6	All relevant outcomes are measured in a standard, valid and reliable way	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable
1.7	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study? *Also indicate number in each arm of the study, at the time the study began, if given*	Control trial within the field.
2.2	What are the main characteristics of the population? *Include all relevant characteristics – e.g. age, sex, health status, location*	*S. anglica*
2.3	If the treatment and control groups are **not** similar at the start of the trial give details of difference here	N/A
2.4	What intervention (treatment, procedure) is being investigated in this study? *List all interventions covered by the study.*	1) Herbicide (Glyphosate 5%, surfactant R-11 1%) 2) Crushing
2.5	What comparisons are made in the study? *Are comparisons made between treatments, or between treatment and control / no treatment group?*	A combination of between treatment and between treatment and control used (within the control trial experiments)
2.6	How long after intervention is the follow-up undertaken in the study?	1 year (herbicide) 2 & 3 years (crushing)
2.7	What outcome measure(s) are used in the study? *List all outcomes that are used to assess effectiveness of the interventions used.*	Proportional Decline (from one to the following year) & (g or No. per $0.25m^2$) 1) Above ground biomass 2) Below ground biomass 3) Spike number 4) Seed number
2.8	What size of effect is identified in the study? *List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.*	*S. anglica* (g or No. per $0.25m^2$) after spraying with 5% Glyphosate and 1% surfactant R-11 (±1se) Skagit Bay, Puget Sound, WA.

	Above-ground biomass (in g)	Below-ground biomass (in g)	Spike No.	Seed No.
Jul 11	30 ± 10	50 ± 10	15 ± 10	5 ± 2.5
Jul 25	27 ± 15	55 ± 7.5	27.5 ± 5	17.5 ± 10
Aug 8	45 ± 25	60 ± 15	25 ± 7.5	32.5 ± 17.5
Aug 22	60 ± 10	65 ± 35	27.5 ± 10	45 ± 12.5
Sep 5	85 ± 20	52 ± 5	25 ± 7.5	57.5 ± 12.5
Sep 19	82 ± 15	57 ± 10	24 ± 7.5	52.5 ± 15
Control	120 ± 5	80 ± 35	24 ± 10	55 ± 12.5

Proportional Decline (from one to the following year) of

<table>
<tr><td></td><td></td><td>
S. anglica after spraying with 5% Glyphosate &1% surfactant R-11(±1se) Skagit Bay, Puget Sound, WA.
<table>
<tr><th></th><th>Above-ground biomass</th><th>Below-ground biomass</th><th>Spike No.</th><th>Seed No.</th></tr>
<tr><td>Jul 11</td><td>0.98 ± 0.02</td><td>0.36 ± 0.02</td><td>1 ± 0</td><td>1 ± 0</td></tr>
<tr><td>Jul 25</td><td>0.98 ± 0.04</td><td>0.4 ± 0.04</td><td>1 ± 0</td><td>1 ± 0</td></tr>
<tr><td>Aug 8</td><td>0.92 ± 0.04</td><td>0.28 ± 0.04</td><td>1 ± 0</td><td>1 ± 0</td></tr>
<tr><td>Aug 22</td><td>0.84 ± 0.08</td><td>0.3 ± 0.04</td><td>1 ± 0</td><td>1 ± 0</td></tr>
<tr><td>Sep 5</td><td>0.90 ± 0.08</td><td>0.3 ± 0.04</td><td>1 ± 0</td><td>1 ± 0</td></tr>
<tr><td>Sep 19</td><td>0.88 ± 0.04</td><td>0.24 ± 0.02</td><td>0.9 ± 0.04</td><td>0.64 ± 0.02</td></tr>
<tr><td>Control</td><td>0 ± 0.16</td><td>0.05 ± 0.06</td><td>0.04 ± 0.12</td><td>0.08 ± 0.08</td></tr>
</table>
Mean (±1se) above and below ground biomass (g per 0.25m^2) of S. anglica after 2, 3, and control years of crushing at 3 plots in Skagit Bay, Puget Sound, WA.
<table>
<tr><th></th><th>Above-ground biomass</th><th>Below-ground biomass</th></tr>
<tr><td>3 years</td><td>20 ± 5</td><td>40 ± 2.5</td></tr>
<tr><td>2 years</td><td>32.5 ± 7.5</td><td>45 ± 5</td></tr>
<tr><td>Control</td><td>120 ± 5</td><td>65 ± 10</td></tr>
</table>
</td></tr>
<tr><td>2.9</td><td>How was this study funded?</td><td>National and Washington Sea Grant programs</td></tr>
<tr><td>2.10</td><td>Does this study help to answer your key question?
Summarise the main conclusions of the study and indicate how it relates to the key question.</td><td>Skipping control efforts for even one year allows S. anglica to rebound quickly, negating the previous years' successes.

Spraying early in the growing season (July) has the greatest effects in terms of reducing subsequent plant growth and seed production over the rest of that season. Spraying late in the season has almost no effect on fertility or growth during that year. Spraying at anytime of the year, however, had a significant negative effect on growth and seed production the following year.</td></tr>
</table>

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Frid, C.L.J., Chandrasekara, W.U., Davey, P., 1999. The restoration of mud flats invaded by common cord-grass (Spartina anglica, CE Hubbard) using mechanical disturbance and its effects on the macrobenthic fauna. Aquatic Conservation-Marine and Freshwater Ecosystems 9, 47-61.

Intervention: **Mechanical** (**Tracked vehicle**)

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

In a well conducted study…..		***In this study this criterion is:***
1.1	The study addresses an appropriate and clearly focused question.	Well covered Not addressed Adequately addressed Not reported

		Poorly addressed	Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.3	If randomised was an adequate concealment method used	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.4	The treatment and control groups are similar at the start of the trial	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.5	The only difference between groups is the treatment under investigation.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.6	All relevant outcomes are measured in a standard, valid and reliable way	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.7	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study? *Also indicate number in each arm of the study, at the time the study began, if given*	A 50x50m area was subjected to the treatment due to logistic and financial limitations. Take five samples from five locations within the treatment and from nearby control and uses those as 25 replicated samples from an unreplicated design.
2.2	What are the main characteristics of the population? *Include all relevant characteristics – e.g. age, sex, health status, location*	*S. anglica*
2.3	If the treatment and control groups are **not** similar at the start of the trial give details of difference here	Treatment and control are on the same submergent saltmarsh at Lindisfarne NNR, UK. However spaced approximately 400m apart.
2.4	What intervention (treatment, procedure) is being investigated in this study? *List all interventions covered by the study.*	Mechanical control by a tracked vehicle repeatedly driving across the salt marsh until the *Spartina* sward were fully dislodged or bide by sediment.
2.5	What comparisons are made in the study? *Are comparisons made between treatments, or between treatment and control / no treatment group?*	Differences between treatment and control
2.6	How long after intervention is the follow-up undertaken in the study? *Length of time subjects is followed, from beginning participation in the study. Note specified end points used to decide end of follow-up (e.g. death, complete cure). Note if follow-up period is shorter than originally planned and reason (if given).*	3 years

2.7	What outcome measure(s) are used in the study? *List all outcomes that are used to assess effectiveness of the interventions used.*	Density of *S. anglica*
2.8	What size of effect is identified in the study? *List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.*	Density (per m^2) of *S. anglica* 3 years after treatment (n=20,± se) Treatment: 43 ± 5 | Control: 80 ± 3.75
2.9	How was this study funded? *List all sources of funding quoted in the article, whether Government, voluntary sector, or industry.*	Association of Commonwealth Universities Scholarship
2.10	Does this study help to answer your key question? *Summarise the main conclusions of the study and indicate how it relates to the key question.*	This study is the first to show the effectiveness of a physical disturbance to control *Spartina* swards on tidal flats and has demonstrated its effectiveness as a management tool. The one-off disturbance by the tracked vehicle resulted in a reduction in the density of the *Spartina* swards over 3 years while having no measurable effect on the infauna. The physical disturbance by the tracked vehicle had no effect on macrobenthic fauna which remained the same as in control areas during the following 12 months.

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Furbish, C.E., Albano, M., 1994. Selective Herbivory and Plant Community Structure in a Mid-Atlantic Salt-Marsh. Ecology 75, 1015-1022.

Intervention: **Simulated grazing experiment**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

	In a well conducted study…..	***In this study this criterion is:***
1.1	The study addresses an appropriate and clearly focused question.	**Well covered** / Adequately addressed / Poorly addressed / Not addressed / Not reported / Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered / **Adequately addressed** / Poorly addressed / Not addressed / Not reported / Not applicable
1.3	If randomised was an adequate concealment method used	Well covered / Adequately addressed / Poorly addressed / **Not addressed** / Not reported / Not applicable
1.4	The treatment and control groups are similar at the start of the trial	Well covered / **Adequately addressed** / Poorly addressed / Not addressed / Not reported / Not applicable
1.5	The only difference between groups is the treatment under investigation.	**Well covered** / Adequately addressed / Poorly addressed / Not addressed / Not reported / Not applicable

1.6	All relevant outcomes are measured in a standard, valid and reliable way	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable
1.7	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study? *Also indicate number in each arm of the study, at the time the study began, if given*	Randomised block design, two enclosures to keep out horses were constructed each containing 3 trail areas (2 different treatments and a control plot). Treatment applied monthly during summer and bimonthly in autumn and spring. During winter only applied if the clipped grasses had grown above 2-3cm
2.2	What are the main characteristics of the population? *Include all relevant characteristics – e.g. age, sex, health status, location*	*S. alterniflora*
2.3	If the treatment and control groups are **not** similar at the start of the trial give details of difference here	N/A
2.4	What intervention (treatment, procedure) is being investigated in this study? *List all interventions covered by the study.*	Treatments under investigation are as follows: 1) Control (no treatment) 2) Simulated preferential grazing (including trampling) of *S. alterniflora* only 3) Non-preferential grazing (including trampling) of both grass species. Simulated grazing achieved by clipping veg. 2-3cm above ground level and removing biomass. Trampling performed by cutters and plugs removed 1cm deep per meter to simulate hooves (every other treatment).
2.5	What comparisons are made in the study? *Are comparisons made between treatments, or between treatment and control / no treatment group?*	Comparisons between both the simulated grazing treatments made and also between treatment and control
2.6	How long after intervention is the follow-up undertaken in the study? *Length of time subjects is followed, from beginning participation in the study. Note specified end points used to decide end of follow-up (e.g. death, complete cure). Note if follow-up period is shorter than originally planned and reason (if given).*	1.5 years (2 growing seasons)
2.7	What outcome measure(s) are used in the study? *List all outcomes that are used to assess effectiveness of the interventions used.*	1) Stems per m2 2) % Cover
2.8	What size of effect is identified in the study? *List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.*	Response of *S. alterniflora* to the simulated grazing experiments (mean ± 1se))

	Control	Preferential grazing	Non-preferential grazing
Stems/m^2	450 ± 98	52 ± 23	249 ± 29
% cover	33.7 ± 5.1	3.3 ± 1.5	14.2 ± 2.3

2.9	How was this study funded?	Assateague Island National Seashore
2.10	Does this study help to answer your key question? *Summarise the main conclusions of the study and indicate how it relates to the key question.*	Non-preferential grazing caused a decline in coverage for both grasses *S. alterniflora* & *Distichlis spicata,* but did not cause reduction of *S. alterniflora* counts. Preferential grazing diminishes *S. alterniflora* coverages and counts, while *D. spicata* coverage increase.

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Garnett, R.P., Hirons, G., Evans, C., O'Connor, D., 1992. The control of Spartina (cord-grass) using glyphosate. Aspects of Applied Biology 29, 359-364.

Intervention: **Herbicide (Glyphosate)**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

In a well conducted study…..		***In this study this criterion is:***	
1.1	The study addresses an appropriate and clearly focused question.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.3	If randomised was an adequate concealment method used	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.4	The treatment and control groups are similar at the start of the trial	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.5	The only difference between groups is the treatment under investigation.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.6	All relevant outcomes are measured in a standard, valid and reliable way	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.7	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study? *Also indicate number in each arm of the study, at the time the study began, if given*	Trials undertaken at 3 sites in the UK (Lindisfarne NNR, RSPB Gayton Sands Reserve, Dee Estuary and Dyfi NNR, Dyfed). Applications made using boom sprayer mounted on ATV, applying 100-200 l/ha spray vol. Plots 200m long and (5.5-10m wide). Each

<table>
<tr><td></td><td></td><td>treatment was replicated twice per site.</td></tr>
<tr><td>2.2</td><td>What are the main characteristics of the population?
Include all relevant characteristics – e.g. age, sex, health status, location</td><td>S. anglica</td></tr>
<tr><td>2.3</td><td>If the treatment and control groups are <u>not</u> similar at the start of the trial give details of difference here</td><td></td></tr>
<tr><td>2.4</td><td>What intervention (treatment, procedure) is being investigated in this study?
List all interventions covered by the study.</td><td>Herbicide
1) Glyphosate (1800g a.e./ha)
2) Glyphosate (1800g a.e./ha) & Mixture B (2% spray sol. – now named Pro-Mix)</td></tr>
<tr><td>2.5</td><td>What comparisons are made in the study?
Are comparisons made between treatments, or between treatment and control / no treatment group?</td><td>Between both treatments and treatment v control plots</td></tr>
<tr><td>2.6</td><td>How long after intervention is the follow-up undertaken in the study?</td><td>1 year</td></tr>
<tr><td>2.7</td><td>What outcome measure(s) are used in the study?
List all outcomes that are used to assess effectiveness of the interventions used.</td><td>1) Shoots/m2
2) % reduction of shoot density
3) % overall control</td></tr>
<tr><td>2.8</td><td>What size of effect is identified in the study?
List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.</td><td>
Effect of Glyphosate on S. anglica one year after treatment at Lindisfarne
<table>
<tr><td></td><td>% reduction vs. shoot density</td><td>Shoot density</td></tr>
<tr><td>Glyphosate 1800</td><td>17</td><td>421.64</td></tr>
<tr><td>Glyphosate 1800 & mixture B (2% spray vol)</td><td>74</td><td>132.08</td></tr>
<tr><td>Control</td><td>0</td><td>508</td></tr>
</table>
Effect of Glyphosate on S. anglica one year after treatment at Dee Estuary
<table>
<tr><td></td><td></td><td colspan="3">No. shoots/m^2 (sd)</td><td></td></tr>
<tr><td>Treat a.e./ha</td><td>Appl. time</td><td>Pioneer zone</td><td>Dense Spartina</td><td>Low marsh</td><td>Overall % control</td></tr>
<tr><td rowspan="3">Glyphosate 1800</td><td>July</td><td>16 (23)</td><td>139 (92)</td><td>59 (60)</td><td>8</td></tr>
<tr><td>Aug</td><td>16 (26)</td><td>148 (95)</td><td>42 (57)</td><td>11</td></tr>
<tr><td>Sept</td><td>23 (30)</td><td>95 (89)</td><td>9 (9)</td><td>55</td></tr>
<tr><td rowspan="3">Glyphosate 1800 & mixture B (2% spray vol)</td><td>July</td><td>1 (1)</td><td>17 (10)</td><td>8 (5)</td><td>89</td></tr>
<tr><td>Aug</td><td>14 (32)</td><td>83 (85)</td><td>50 (66)</td><td>37</td></tr>
<tr><td>Sept</td><td>4 (5)</td><td>32 (23)</td><td>9 (31)</td><td>81</td></tr>
<tr><td>Control</td><td></td><td>13 (24)</td><td>132 (115)</td><td>87 (60)</td><td>0</td></tr>
</table>
</td></tr>
<tr><td>2.9</td><td>How was this study funded?
List all sources of funding quoted in the article, whether Government, voluntary sector, or industry.</td><td>Not reported</td></tr>
<tr><td>2.10</td><td>Does this study help to answer your key question?
Summarise the main conclusions of the study and indicate how it relates to the key question.</td><td>The addition of Mixture B to Glyphosate (1800g a.e./ha) greatly increased its effect on S. anglica.
Excellent control was given by a mixture of Glyphosate with an additive, particularly when applied in July. Monitoring of invertebrate populations showed that use of Glyphosate alone only had minor effects, while the use of additive Mixture B caused short term decline of</td></tr>
</table>

		some species. It is essential to have maximum time before sea covers the treated areas, so applications should be made on neap tides, as shown by poor results at the Dyfi estuary (not reported in study). Treatments should be made when *Spartina* is reaching maturity and growing actively.

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Goodman, P.J., 1960. Investigations into `Die-Back' in Spartina Townsendii Agg: II. The Morphological Structure and Composition of the Lymington Sward. The Journal of Ecology 48, 711-724.

Intervention: **Cutting** (and perhaps simulated grazing)

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

In a well conducted study…..		***In this study this criterion is:***	
1.1	The study addresses an appropriate and clearly focused question.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.3	If randomised was an adequate concealment method used	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.4	The treatment and control groups are similar at the start of the trial	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.5	The only difference between groups is the treatment under investigation.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.6	All relevant outcomes are measured in a standard, valid and reliable way	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.7	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study? *Also indicate number in each arm of the study, at the time the study began, if given*	Quadrats of $1m^2$ divided into subquatrats. Each quadrat had a pretreatment value taken then cut to ground-level.
2.2	What are the main characteristics of the population?	*S. townsendii*

<table>
<tr><td>2.3</td><td>If the treatment and control groups are <u>not</u> similar at the start of the trial give details of difference here</td><td>N/A</td></tr>
<tr><td>2.4</td><td>What intervention (treatment, procedure) is being investigated in this study?
List all interventions covered by the study.</td><td>Cutting (clipping) all plants to ground level.</td></tr>
<tr><td>2.5</td><td>What comparisons are made in the study?
Are comparisons made between treatments, or between treatment and control / no treatment group?</td><td>Before and after treatment</td></tr>
<tr><td>2.6</td><td>How long after intervention is the follow-up undertaken in the study?</td><td>1 year</td></tr>
<tr><td>2.7</td><td>What outcome measure(s) are used in the study?
List all outcomes that are used to assess effectiveness of the interventions used.</td><td>1) No. of inflorescences
2) No. of live shoots
3) Fresh weight (g) of live shoots
4) No. of dead shoots
5) Av. Height of live shoots
6) Av. Leaf No. per live shoot
7) Air-dry weight (g) of live rhizomes and roots</td></tr>
<tr><td>2.8</td><td>What size of effect is identified in the study?
List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.</td><td>Sward differences between sites before & after cutting
<table>
<tr><td></td><td colspan="2">Healthy sward</td><td colspan="2">Pan ‘die-back’</td><td colspan="2">Channel ‘die-back’</td></tr>
<tr><td></td><td>Before</td><td>After</td><td>Before</td><td>After</td><td>Before</td><td>After</td></tr>
<tr><td></td><td>Sept. 55</td><td>Aug. 56</td><td>Sept. 55</td><td>Aug. 56</td><td>Sept. 55</td><td>Aug. 56</td></tr>
<tr><td>1</td><td>15</td><td>11</td><td>1</td><td>0</td><td>2</td><td>0</td></tr>
<tr><td>2</td><td>66</td><td>78</td><td>22</td><td>21</td><td>42</td><td>31</td></tr>
<tr><td>3</td><td>145</td><td>66</td><td>58</td><td>10</td><td>78</td><td>25</td></tr>
<tr><td>4</td><td>49</td><td>0</td><td>8</td><td>0</td><td>9</td><td>0</td></tr>
<tr><td>5</td><td>45</td><td>15</td><td>25</td><td>12</td><td>26</td><td>25</td></tr>
<tr><td>6</td><td>6.7</td><td>3.9</td><td>7.8</td><td>3.8</td><td>6.5</td><td>4.6</td></tr>
<tr><td>7</td><td>10.9</td><td>5.9</td><td>2.1</td><td>0.5</td><td>2.1</td><td>2.4</td></tr>
</table></td></tr>
<tr><td>2.9</td><td>How was this study funded?</td><td>Not reported</td></tr>
<tr><td>2.10</td><td>Does this study help to answer your key question?
Summarise the main conclusions of the study and indicate how it relates to the key question.</td><td>The chief effect of cutting healthy Spartina sward in September was to induce vigorous spring and summer bud growth. The developing shoots had few leaves, and were light in weight, none the less, they produced a crop of inflorescences almost as vigorous as that of the uncut sward.</td></tr>
</table>

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Goranson, C.E., Ho, C.K., Pennings, S.C., 2004. Environmental gradients and herbivore feeding preferences in coastal salt marshes. Oecologia 140, 591-600.

Intervention: **Herbivory (*Orphulella* & *Orchelimum*)**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

In a well conducted study…..		***In this study this criterion is:***	
1.1	The study addresses an appropriate and clearly focused question.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable

1.3	If randomised was an adequate concealment method used	Well covered / Adequately addressed / Poorly addressed / Not addressed / Not reported / Not applicable
1.4	The treatment and control groups are similar at the start of the trial	Well covered / Adequately addressed / Poorly addressed / Not addressed / Not reported / **Not applicable**
1.5	The only difference between groups is the treatment under investigation.	**Well covered** / Adequately addressed / Poorly addressed / Not addressed / Not reported / Not applicable
1.6	All relevant outcomes are measured in a standard, valid and reliable way	**Well covered** / Adequately addressed / Poorly addressed / Not addressed / Not reported / Not applicable
1.7	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Well covered / Adequately addressed / Poorly addressed / Not addressed / Not reported / **Not applicable**

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study? *Also indicate number in each arm of the study, at the time the study began, if given*	Undertaken in June-August 2000, on Sapelao Island, Georgia, USA. No control plots – However measures for high salt and low salt leaf consumption are given. Leafs are standardised to minimise confounding features such as age.
2.2	What are the main characteristics of the population? *Include all relevant characteristics – e.g. age, sex, health status, location*	*S. alterniflora*
2.3	If the treatment and control groups are **not** similar at the start of the trial give details of difference here	High salt and low salt habitats
2.4	What intervention (treatment, procedure) is being investigated in this study? *List all interventions covered by the study.*	Herbivory from Orthoptera *Orphulella pelidna* *Orchelimum fidicinum*
2.5	What comparisons are made in the study? *Are comparisons made between treatments, or between treatment and control / no treatment group?*	Between High and Low salt habitats
2.6	How long after intervention is the follow-up undertaken in the study? *Length of time subjects is followed, from beginning participation in the study. Note specified end points used to decide end of follow-up (e.g. death, complete cure). Note if follow-up period is shorter than originally planned and reason (if given).*	72 hours
2.7	What outcome measure(s) are used in the study? *List all outcomes that are used to assess effectiveness of the interventions used.*	Leaf area consumed (mm^2)
2.8	What size of effect is identified in the study? *List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.*	Trials of consumption of leaves from plants growing in high-salt vs. low-salt habitats (mean ± 1 se).

	Orphulella	***Orchelimum***
High-salt	37.5 ± 7.5	40 ± 5
Low-salt	60 ± 7.5	20 ± 5

2.9	How was this study funded? *List all sources of funding quoted in the article, whether Government, voluntary sector, or industry.*	University of Georgia Marine Institute Intern Program, Environmental Institute of Houston and NSF grant
2.10	Does this study help to answer your key question? *Summarise the main conclusions of the study and indicate how it relates to the key question.*	Both species preferred leaves from low-salt habitat. However *Orphulella* consumed greater amounts from low-salt habitats while *Orchelimum* consumed greater amounts from high-salt habitats.

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Grevstad, F.S., Strong, D.R., Garcia-Rossi, D., Switzer, R.W., Wecker, M.S., 2003. Biological control of Spartina alterniflora in Willapa Bay, Washington using the planthopper Prokelisia marginata: Agent specificity and early results. Biological Control 27, 32-42.

Intervention: **Herbivory (*Prokelisia marginata*)**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

In a well conducted study…..		***In this study this criterion is:***	
1.1	The study addresses an appropriate and clearly focused question.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.3	If randomised was an adequate concealment method used	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.4	The treatment and control groups are similar at the start of the trial	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.5	The only difference between groups is the treatment under investigation.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.6	All relevant outcomes are measured in a standard, valid and reliable way	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.7	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study? *Also indicate number in each arm of the study, at the*	Caged field release of *P. marginata* as an assessment of impact. Cages 1.52m x1.52m PVC pipe frame with fabric

<table>
<tr><td></td><td>time the study began, if given</td><td>covers. 2300 insects released into one cage at two sites and 2 cages at 1 site with 1 adjacent control cage at each site left empty of insects. Treatment initiated in mid-May results taken in Sept. Three quadrats were randomly taken from each cage.</td></tr>
<tr><td>2.2</td><td>What are the main characteristics of the population?
Include all relevant characteristics – e.g. age, sex, health status, location</td><td>S. alterniflora

P. marginata as the biological control agent</td></tr>
<tr><td>2.3</td><td>If the treatment and control groups are <u>not</u> similar at the start of the trial give details of difference here</td><td>N/A</td></tr>
<tr><td>2.4</td><td>What intervention (treatment, procedure) is being investigated in this study?
List all interventions covered by the study.</td><td>Herbivory
2300 P. marginata in each cage at field release plots on a saltmarsh in Willapa Bay, Washington.</td></tr>
<tr><td>2.5</td><td>What comparisons are made in the study?
Are comparisons made between treatments, or between treatment and control / no treatment group?</td><td>Between treatment and control</td></tr>
<tr><td>2.6</td><td>How long after intervention is the follow-up undertaken in the study?</td><td>4 months</td></tr>
<tr><td>2.7</td><td>What outcome measure(s) are used in the study?
List all outcomes that are used to assess effectiveness of the interventions used.</td><td>1) Above ground (dry) biomass (g m^2)
2) Plant height (cm)</td></tr>
<tr><td>2.8</td><td>What size of effect is identified in the study?
List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.</td><td>Impact of P. marginata on S. alterniflora at 3 release sites in Willapa Bay
<table>
<tr><td></td><td colspan="2">Tarlatt Slough</td><td colspan="2">Smith Creek</td><td colspan="2">Lewis Slough</td></tr>
<tr><td>Measure</td><td>C</td><td>T</td><td>C</td><td>T</td><td>C</td><td>T</td></tr>
<tr><td>1</td><td>615.5 ± 77</td><td>308 ± 50</td><td>1550 ± 270</td><td>193 ± 40</td><td>808 ± 77</td><td>500 ± 40</td></tr>
<tr><td>2</td><td>183.6 ± 4</td><td>154.2 ± 4</td><td>180 ± 5</td><td>150 ± 5</td><td>162.6 ± 4</td><td>146 ± 4</td></tr>
</table></td></tr>
<tr><td>2.9</td><td>How was this study funded?
List all sources of funding quoted in the article, whether Government, voluntary sector, or industry.</td><td>US Fish & Wildlife Service, US Forest Service, National Sea Grant Program, the Coastal Zone Management Program, the Coastal Resource Alliance, the Washington Dept. of Fish & Wildlife Volunteer Cooperative Grant Program, the Dept. of Ecology Shorelands Office, Pacific County Dept. The Washington Dept. of Natural Resources and Willapa National Wildlife Refuge</td></tr>
<tr><td>2.10</td><td>Does this study help to answer your key question?
Summarise the main conclusions of the study and indicate how it relates to the key question.</td><td>More than one year after the first release of P. marginata into Willapa Bay, the outlook for the biological control program against S. alterniflora is encouraging. Out host range tests indicate that this planthopper is highly specialised to a small group of closely related Spartina species. In addition to the target species, P. marginata will feed readily and complete its life cycle only on S. foliosa and S. anglica.

The ability to persist, grow and spread in Willapa Bay is important, but ultimately successful biocontrol comes only with an impact on the weed. The impact experiment confirms the exceptional vulnerability of Willapa Bay S. alterniflora in field conditions.</td></tr>
</table>

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Hacker, S.D., Heimer, D., Hellquist, C.E., Reeder, T.G., Reeves, B., Riordan, T.J., Dethier, M.N., 2001. A marine plant (Spartina anglica) invades widely varying habitats: Potential mechanisms of invasion and control. Biological Invasions 3, 211-217.

Intervention: **Herbicide (Glyphosate)**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

In a well conducted study…..		***In this study this criterion is:***	
1.1	The study addresses an appropriate and clearly focused question.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.3	If randomised was an adequate concealment method used	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.4	The treatment and control groups are similar at the start of the trial	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.5	The only difference between groups is the treatment under investigation.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.6	All relevant outcomes are measured in a standard, valid and reliable way	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.7	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study? *Also indicate number in each arm of the study, at the time the study began, if given*	Time-series Survey method using 1997 pre-treatment survey to 2000 survey to calculate the change in area. This was achieved by subtracting the solid area treated by the solid area untreated (but infested). The difference is defined as the amount of *S. anglica* removed (no regrowth) from the site.
2.2	What are the main characteristics of the population? *Include all relevant characteristics – e.g. age, sex, health status, location*	*S. anglica*
2.3	If the treatment and control groups are **not** similar at the start of the trial give details of difference here	The trail was undertaken on the same salt-marsh but details of the locations are sketchy.

2.4	What intervention (treatment, procedure) is being investigated in this study? *List all interventions covered by the study.*	**Mowing & Herbicide (Glyphosate)**
2.5	What comparisons are made in the study? *Are comparisons made between treatments, or between treatment and control / no treatment group?*	Before and after treatment using surveys of the region
2.6	How long after intervention is the follow-up undertaken in the study?	**4 years**
2.7	What outcome measure(s) are used in the study? *List all outcomes that are used to assess effectiveness of the interventions used.*	% decline of *S. anglica*
2.8	What size of effect is identified in the study? *List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.*	26% decline of *S. anglica* in treated area since 1997. Treatment depends on habitat type with: High Salinity Marshes having the greatest decline = 71% or 18.3ha removed of the 25.6ha treated area. Low Salinity Marshes having smallest decline = 10% or 8.7ha of the 84.6ha treated area. Mud Flat conversions = 29% or 22.8ha removed of 78.3 treated. Cobble Beeches = 21% or 2.4ha of the 11.1ha treated.
2.9	How was this study funded? *List all sources of funding quoted in the article, whether Government, voluntary sector, or industry.*	WSDA, WSDFW, Betty Higinbotham Trust award, Padilla Bay Research Assistantship, National Sea Grant College Program.
2.10	Does this study help to answer your key question? *Summarise the main conclusions of the study and indicate how it relates to the key question.*	Removal of *S. anglica* within Puget Sound has been modest but promising. Four years of removal treatments on half the invasion area has resulted in 26% decline or approximately 13% for the entire invasion. When habitat specific *S. anglica* removal success is considered, we find that high-salinity marsh have the greatest decline, low salinity marsh have the lowest decline. Mud flats and low salinity marshes are most invaded by *S. anglica* and appears unhindered by the physical conditions of these habitats.

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Hammond, M.E.R., 2001. The experimental control of Spartina anglica and Spartina x townsendii in estuarine salt marsh. Ph.D. Thesis, Ulster.

Intervention: **Herbicides (Dalapon & Glyphosate) Cutting (with herbicide, with smothering or alone)**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

In a well conducted study…..		***In this study this criterion is:***	
1.1	The study addresses an appropriate and clearly focused question.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable

1.2	The assignment of subjects to treatment groups is randomised	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable
1.3	If randomised was an adequate concealment method used	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable
1.4	The treatment and control groups are similar at the start of the trial	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable
1.5	The only difference between groups is the treatment under investigation.	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable
1.6	All relevant outcomes are measured in a standard, valid and reliable way	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable
1.8	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study? *Also indicate number in each arm of the study, at the time the study began, if given*	Randomised block design angled approximately with the shoreline, described in detail (incl. figures of layout). Seven treatments (incl. control) assigned to one of the 32 0.5m x 0.5m plots.
2.2	What are the main characteristics of the population? *Include all relevant characteristics – e.g. age, sex, health status, location*	*S. anglica* at two sites in N. Ireland (Lough Foyle & Strangford Lough)
2.3	If the treatment and control groups are **not** similar at the start of the trial give details of difference here	
2.4	What intervention (treatment, procedure) is being investigated in this study? *List all interventions covered by the study.*	Experiments Control (no treatment) Dalapon 57kg/ha Glyphosate (without surfactant) 5.0l/ha Cut (10cm) Cut (10cm) & Dalapon applied 6 weeks later Cut (10cm) & Glyphosate applied 6 weeks later Cut (10cm) & covered with black plastic sheeting for 6 months
2.5	What comparisons are made in the study?	Between each treatment and between treatment and control
2.6	How long after intervention is the follow-up undertaken in the study?	1 & 2 years
2.7	What outcome measure(s) are used in the study?	Stem Density (per 0.25m^2) Stem Height (cm)
2.8	What size of effect is identified in the study? *List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.*	Study plots raw data - S. anglica agg. stem density per 0.25 m^2

	BALLYKELLY				BALLYDRAIN			
	1999		2000		1999		2000	
	mean	sd	mean	sd	mean	sd	mean	sd
Dalapon	2.17	1.9	25.4	17	3.87	4.3	7.1	8.7
Cut + Glyphosate	85.63	22.1	59.57	14.2	50.87	28.7	60.47	34.1
Control	48.03	10.9	82.4	16.3	47.7	23.1	50.17	15.5
Glyphosate	47.6	15.2	94.57	14	40.57	16.4	59.5	23.1
Cut + Smother	0.57	0.9	5.4	7.3	0.1	0.2	0.2	0.1
Cut	86.72	22	58.67	15.5	76.53	43.8	79.7	35.6

		Cut + Dalapon | 2.1 | 1.3 | 27.73 | 4.9 | 2.6 | 1.1 | 1.83 | 2

Study plots raw data - S. anglica agg. stem height (cm)

1999	BALLYKELLY		BALLYDRAIN	
	mean	sd	mean	sd
Dalapon	11.45	1.9	17.46	4.9
Cut + Glyphosate	23.75	3.3	15.63	2.7
Control	45.18	1.8	24.34	3.9
Glyphosate	26.26	5.3	19.59	2.4
Cut + Smother	7.55	6.1	4.23	4.8
Cut	35.61	5.3	15.88	2.6
Cut + Dalapon	13.36	1.3	5.69	4.6

2.9	How was this study funded?	Dept. of Environment & Heritage Service Northern Ireland, Dept of Education Northern Ireland Co-operative Assisted Science & Technology (Cast) Award.
2.10	Does this study help to answer your key question? *Summarise the main conclusions of the study and indicate how it relates to the key question.*	In this study, rapid S. anglica agg. re-growth and re-colonisation by seedlings (at Ballydrain) occurred during the second year after dalapon application. Live S. anglica agg. stem density had increased by over 1200% at Ballykelly and over 200% at Ballydrain compared to records from the previous years. It was noted that glyphosate caused visible browning of the *S. anglica* agg. leaves, but did not have effects on live stem density the following year. This suggests that glyphosate killed the above ground growth but did not penetrate or kill the *S. anglica* agg. root and rhizome system. Cutting had no additive effect when applied before herbicides in this study. The single-cut treatments produced the highest live stem density values at each site The smothering treatment had kill rates close to 100%. Smothering was also the only method in which dry root weight was lower or the same as the previous year.

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Hammond, M.E.R., Cooper, A., 2003. Spartina anglica eradication and inter-tidal recovery in Northern Ireland estuaries. (Occasional Paper of the IUCN Species Survival Commission No.27). In Turning the tide: the eradication of invasive species: Proceedings of the International Conference on eradication of island invasives, pp. 124-131. IUCN-The World Conservation Union, Gland, Switzerland.

Intervention: **Herbicides (Dalapon & Glyphosate) Cutting (with herbicide, with smothering or alone)**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

In a well conducted study…..		***In this study this criterion is:***
1.1	The study addresses an appropriate and clearly focused question.	Well covered / Adequately addressed / Poorly addressed / Not addressed / Not reported / Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered / Adequately addressed / Poorly addressed / Not addressed / Not reported / Not applicable

1.3	If randomised was an adequate concealment method used	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable
1.4	The treatment and control groups are similar at the start of the trial	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable
1.5	The only difference between groups is the treatment under investigation.	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable
1.6	All relevant outcomes are measured in a standard, valid and reliable way	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable
1.8	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study? *Also indicate number in each arm of the study, at the time the study began, if given*	Randomised block design angled approximately with the shoreline, described in detail (incl. figures of layout). Seven treatments (incl. control) assigned to one of the 32 0.5m x 0.5m plots. Please note this is a paper based on the previous PhD thesis.
2.2	What are the main characteristics of the population? *Include all relevant characteristics – e.g. age, sex, health status, location*	*S. anglica* at two sites in N. Ireland (Lough Foyle & Strangford Lough)
2.3	If the treatment and control groups are **not** similar at the start of the trial give details of difference here	Lough Foyle pre-treatment av. stem density of 232 stems/m2 & av. Height = 33.2cm Strangford Lough pre-treatment av. stem density of 336 stems/m2 & av. Height = 23.7cm
2.4	What intervention (treatment, procedure) is being investigated in this study? *List all interventions covered by the study.*	Experiments Control (no treatment) Dalapon 57kg/ha Glyphosate (without surfactant) 5.0l/ha Cut (10cm) Cut (10cm) & Dalapon applied 6 weeks later Cut (10cm) & Glyphosate applied 6 weeks later Cut (10cm) & covered with black plastic sheeting for 6 months
2.5	What comparisons are made in the study? *Are comparisons made between treatments, or between treatment and control / no treatment group?*	Between each treatment and between treatment and control
2.6	How long after intervention is the follow-up undertaken in the study?	**1 & 2 years**
2.7	*What outcome measure(s) are used in the study?*	% change in live *S. anglica* stem density
2.8	What size of effect is identified in the study? *List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.*	Percentage changes in live S. anglica stem density between July 1998 – July 1999 or July 2000 at both study sites.

	Lough Foyle		Strangford Lough	
	1998-99	1998-00	1998-99	1998-00
Cut	+50.3	+1.7	-2.0	+2.0

		Cut + Dalapon	-96.8	-58.1	-99.6	-98.0
		Cut + Glyphosate	+58.8	+10.6	-25.4	-11.3
		Cut + Smother	-98.6	-90.3	-99.9	-99.9
		Dalapon	-96.3	-57.5	-95.8	-92.3
		Glyphosate	-14.8	+69.1	-52.2	-30.0
		Control	-15.3	+45.3	-52.6	-50.1
2.9	How was this study funded?	Dept. of Environment & Heritage Service Northern Ireland, Dept of Education Northern Ireland Co-operative Assisted Science & Technology (Cast) Award.				
2.10	Does this study help to answer your key question? *Summarise the main conclusions of the study and indicate how it relates to the key question.*	Herbicides are the most frequently used *Spartina* spp. Control method due to their practical ease of use and cost-effectiveness. This study shows that when used in suitable conditions, Dalapon applied at a rate of 57kg/ha will cause over 95% reduction in live *S. anglica* stem density within the first year. Glyphosate was as ineffective with similar live *S. anglica* stem densities as the experimental control. Cutting had no additive effect when applied before Dalapon application. The single cut produced the highest live stem density values, therefore not assisting *Spartina* eradication. Smothering caused over 95% reductions in live *S. anglica* stem density. The experimental treatments failed to achieve 100% kill of *S. anglica*. Eradication would require repeat applications of eradication treatments, possible on many occasions.				

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Hannaford, J., Pinn, E.H., Diaz, A., 2006. The impact of sika deer grazing on the vegetation and infauna of Arne saltmarsh. Marine Pollution Bulletin 53, 56-62.

Intervention: **Herbivory (sika deer)**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

In a well conducted study…..		***In this study this criterion is:***	
1.1	The study addresses an appropriate and clearly focused question.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.3	If randomised was an adequate concealment method used	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.4	The treatment and control groups are similar at the start of the trial	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable

1.5	The only difference between groups is the treatment under investigation.	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable
1.6	All relevant outcomes are measured in a standard, valid and reliable way	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable
1.7	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study? *Also indicate number in each arm of the study, at the time the study began, if given*	Survey of saltmarsh during 2002 to establish impact of herbivory damage and veg. diversity. Pre-existing fenced enclosures and areas considered ungrazed were used as a comparison. The experiment takes place at 3 sites, between 0.5-1.5km apart across the Arne saltmarsh, U.K.
2.2	What are the main characteristics of the population? *Include all relevant characteristics – e.g. age, sex, health status, location*	*S. anglica* Herbivore (*Cervus Nippon* - sika deer)
2.3	If the treatment and control groups are **not** similar at the start of the trial give details of difference here	
2.4	What intervention (treatment, procedure) is being investigated in this study? *List all interventions covered by the study.*	Herbivory by *C. Nippon*
2.5	What comparisons are made in the study? *Are comparisons made between treatments, or between treatment and control / no treatment group?*	Between grazed, ungrazed and fenced areas
2.6	How long after intervention is the follow-up undertaken in the study?	Not reported
2.7	What outcome measure(s) are used in the study? *List all outcomes that are used to assess effectiveness of the interventions used.*	% cover ± 1 se
2.8	What size of effect is identified in the study? *List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.*	Percentage cover (mean ± 1se) of *S. anglica*

	Grazed	Ungrazed	Fenced
S. anglica	12 ± 2.5	95 ± 1	85 ± 5

2.9	How was this study funded? *List all sources of funding quoted in the article, whether Government, voluntary sector, or industry.*	Not reported
2.10	Does this study help to answer your key question? *Summarise the main conclusions of the study and indicate how it relates to the key question.*	Grazing appeared to have an impact on vegetation diversity and abundance but only at a localized level. S. anglica was much less abundant in grazed areas while other species such as Salicornia ramosissima and Halimione portulacoides were more abundant. In addition bare mud was significantly increased in the grazed areas.

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Hubbard, J.C.E., 1970. Effects of Cutting and Seed Production in Spartina Anglica. The Journal of Ecology 58, 329-334.

Intervention: **Cutting**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

	In a well conducted study…..	***In this study this criterion is:***
1.1	The study addresses an appropriate and clearly focused question.	Well covered / Adequately addressed / Poorly addressed / Not addressed / Not reported / Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered / Adequately addressed / Poorly addressed / Not addressed / **Not reported** / Not applicable
1.3	If randomised was an adequate concealment method used	Well covered / Adequately addressed / Poorly addressed / Not addressed / **Not reported** / Not applicable
1.4	The treatment and control groups are similar at the start of the trial	Well covered / **Adequately addressed** / Poorly addressed / Not addressed / Not reported / Not applicable
1.5	The only difference between groups is the treatment under investigation.	Well covered / **Adequately addressed** / Poorly addressed / Not addressed / Not reported / Not applicable
1.6	All relevant outcomes are measured in a standard, valid and reliable way	**Well covered** / Adequately addressed / Poorly addressed / Not addressed / Not reported / Not applicable
1.7	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Well covered / Adequately addressed / Poorly addressed / Not addressed / Not reported / **Not applicable**

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study? *Also indicate number in each arm of the study, at the time the study began, if given*	Control Trial, replicated on four 5x5m plots at two sites (Bridgwater Bay, Somerset and Poole Harbour Dorset U.K.). Plots cut to ground level every month from June to October.
2.2	What are the main characteristics of the population? *Include all relevant characteristics – e.g. age, sex, health status, location*	*S. anglica*
2.3	If the treatment and control groups are **not** similar at the start of the trial give details of difference here	N/A
2.4	What intervention (treatment, procedure) is being investigated in this study?	Cutting to ground level (5 cuts per plot)

	List all interventions covered by the study.	
2.5	What comparisons are made in the study? *Are comparisons made between treatments, or between treatment and control / no treatment group?*	Between treatment and control
2.6	How long after intervention is the follow-up undertaken in the study?	11 months from last cut
2.7	What outcome measure(s) are used in the study? *List all outcomes that are used to assess effectiveness of the interventions used.*	1) Density (shoots/m^2) 2) Dry weight (g/m^2)
2.8	What size of effect is identified in the study? *List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.*	Density and dry weight of *S. anglica* harvested from treatment and control plot on Keysworth Marsh, Poole Harbour.

	Treatment	Control
shoots/m2	1500 (1055 vegetative shoots & 445 flowering shoots)	389
Dry weight (g/m2)	255	277.5

2.9	How was this study funded?	Not reported
2.10	Does this study help to answer your key question? *Summarise the main conclusions of the study and indicate how it relates to the key question.*	In a Spartina marsh subjected to repetitive cutting (5 cuts), growth during the following year was more uniform in height, denser and earlier in flowering than in control plots. The effects of treatment persisted for more than one summer. Light is a limiting factor to germination – seeds require to be buried prior to germination. Similarly temperature is also important with seeds dormant at less than 4°C, but germination occurs between 7 to 25°C.

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Johnson, L.A., Foote, A.L., 1997. Vertebrate herbivory in managed coastal wetlands: A manipulative experiment. Aquatic Botany 59, 17-32.

Intervention: **Herbivory (*Myocastor* coypus - nutria)**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

In a well conducted study…..		***In this study this criterion is:***	
1.1	The study addresses an appropriate and clearly focused question.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.3	If randomised was an adequate concealment method used	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable

1.4	The treatment and control groups are similar at the start of the trial	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable
1.5	The only difference between groups is the treatment under investigation.	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable
1.6	All relevant outcomes are measured in a standard, valid and reliable way	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable
1.7	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study? *Also indicate number in each arm of the study, at the time the study began, if given*	Five 9m^2 exclosures (fenced and ungrazed) and five 9m^2 control (unfenced and grazed) plots were constructed in each of the managed and unmanaged areas to test the effects of nutria grazing on aboveground biomass. Experiment undertaken on mesohaline wetlands located 35km south of New Orleans, Louisiana, USA.
2.2	What are the main characteristics of the population?	S. patens
2.3	If the treatment and control groups are **not** similar at the start of the trial give details of difference here	Treatment plots are fenced and control plots unfenced.
2.4	What intervention (treatment, procedure) is being investigated in this study?	Herbivory by *Myocastor* coypus – nutria (a rodent)
2.5	What comparisons are made in the study? *Are comparisons made between treatments, or between treatment and control / no treatment group?*	Between treatment and control and between years
2.6	How long after intervention is the follow-up undertaken in the study?	Sampling occurred every 2-3 months 1991/92 and every 5-6 months 1993/94
2.7	What outcome measure(s) are used in the study? *List all outcomes that are used to assess effectiveness of the interventions used.*	Aboveground biomass (g/m^2)
2.8	What size of effect is identified in the study? *List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.*	Aboveground biomass (g/m^2) response to herbivory

	Treatment	Control
4/91 (2 months)	180 ± 40	160 ± 30
6/91 (4 months)	240 ± 80	340 ± 80
8/91 (6 months)	300 ± 60	500 ± 100
10/91 (8 months)	400 ± 100	700 ± 120
1/92 (11 months)	240 ± 80	540 ± 80
3/92 (13 months)	300 ± 80	840 ± 160
5/92 (15 months)	440 ± 100	900 ± 160
7/92 (18 months)	600 ± 120	850 ± 150
10/92 (21 months)	860 ± 200	1360 ± 200
12/92 (23 months)	910 ± 200	1300 ± 240
5/93 (27 months)	900 ± 200	1700 ± 320
11/93 (33 months)	1740 ± 440	1500 ± 200
4/94 (38 months)	1060 ± 280	1200 ± 160
10/94 (44 months)	650 ± 200	500 ± 80

2.9	How was this study funded?	Not reported
2.10	Does this study help to answer your key question? *Summarise the main conclusions of the study and indicate how it relates to the key question.*	Although grazed and ungrazed plots were similar when analyzed by sampling date, there was a difference in the biomass change over time. Nutria grazing was insufficient to reduce above-ground biomass of *S. patens*. The brackish leaves of this species is not the preferred food in saltmarshes. Nutria however did grub for roots and rhizomes over winter, leaving behind a mixed stand of dead, rootless stems and living intact stems. Root herbivory removes belowground biomass and subsequently thins the aboveground stand via stem mortality.

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Kilbride, K.M., Paveglio, F.L., Grue, C.E., 1995. Control of Smooth Cordgrass with Rodeo(R) in a Southwestern Washington Estuary. Wildlife Society Bulletin 23, 520-524.

Intervention: **Herbicide (Rodeo® - containing Glyphosate)**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

In a well conducted study…..		***In this study this criterion is:***	
1.1	The study addresses an appropriate and clearly focused question.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.3	If randomised was an adequate concealment method used	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.4	The treatment and control groups are similar at the start of the trial	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.5	The only difference between groups is the treatment under investigation.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.6	All relevant outcomes are measured in a standard, valid and reliable way	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.7	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

<table>
<tr><td>2.1</td><td>What is the experimental design used in this study?
Also indicate number in each arm of the study, at the time the study began, if given</td><td>Control Trial (1 treatment and 1 control) across 4 sites in Willapa Bay, Washington.</td></tr>
<tr><td>2.2</td><td>What are the main characteristics of the population?
Include all relevant characteristics – e.g. age, sex, health status, location</td><td>S. alterniflora</td></tr>
<tr><td>2.3</td><td>If the treatment and control groups are <u>not</u> similar at the start of the trial give details of difference here</td><td>N/A</td></tr>
<tr><td>2.4</td><td>What intervention (treatment, procedure) is being investigated in this study?
List all interventions covered by the study.</td><td>Herbicide – Rodeo® either sprayed at low tide:
Aerially from a Soloy Bay-47 helicopter equipped with a 9.8m toe-mounted boom. Volume applied 93.5 l/ha with Rodeo at 4.7 l/ha and X-77 spreader at 0.9 l/ha.
or
Ground with hand-held wand and Rodeo (5% sol.) and X-77 spreader (1% sol).</td></tr>
<tr><td>2.5</td><td>What comparisons are made in the study?
Are comparisons made between treatments, or between treatment and control / no treatment group?</td><td>Between treatments and treatment v control</td></tr>
<tr><td>2.6</td><td>How long after intervention is the follow-up undertaken in the study?</td><td>11 months</td></tr>
<tr><td>2.7</td><td>What outcome measure(s) are used in the study?
List all outcomes that are used to assess effectiveness of the interventions used.</td><td>Density (stems/m^2)</td></tr>
<tr><td>2.8</td><td>What size of effect is identified in the study?
List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.</td><td>Density of S. alterniflora clones on 1ha plots using different control methods (A = Ariel, G = ground & C = control)
<table>
<tr><td></td><td></td><td colspan="2">Pre-treatment</td><td colspan="2">Post treatment</td><td></td></tr>
<tr><td>Location</td><td>Treatment</td><td>mean</td><td>se</td><td>mean</td><td>se</td><td>% change</td></tr>
<tr><td rowspan="2">Seal Slough</td><td>C (5)</td><td>218.8</td><td>18.7</td><td>182.0</td><td>17.8</td><td>-16.8</td></tr>
<tr><td>A (5)</td><td>205.4</td><td>20.4</td><td>197.4</td><td>17.4</td><td>-3.9</td></tr>
<tr><td rowspan="2">Potshot Slough</td><td>C (5)</td><td>366.0</td><td>49.0</td><td>397.5</td><td>49.5</td><td>8.5</td></tr>
<tr><td>A (5)</td><td>363.4</td><td>38.3</td><td>229.7</td><td>90.9</td><td>-36.8</td></tr>
<tr><td rowspan="3">Porter Point</td><td>C (5)</td><td>490.9</td><td>13.0</td><td>398.3</td><td>23.4</td><td>-18.9</td></tr>
<tr><td>A (5)</td><td>497.6</td><td>46.4</td><td>296.9</td><td>35.1</td><td>-40.3</td></tr>
<tr><td>G (10)</td><td>484.9</td><td>18.3</td><td>77.2</td><td>26.3</td><td>-84.1</td></tr>
<tr><td rowspan="2">Combined</td><td>C (15)</td><td>358.6</td><td>34.1</td><td>325.9</td><td>32.5</td><td>-9.1</td></tr>
<tr><td>A (15)</td><td>355.5</td><td>37.5</td><td>241.4</td><td>32.5</td><td>-32.1</td></tr>
</table></td></tr>
<tr><td>2.9</td><td>How was this study funded?</td><td>Washington State Department of Natural Resources and US Fish and Wildlife Service.</td></tr>
<tr><td>2.10</td><td>Does this study help to answer your key question?
Summarise the main conclusions of the study and indicate how it relates to the key question.</td><td>Although not different from controls, the greatest decrease in stem densities for aerially treated clones occurred at Porter Point. These clones were located higher in the intertidal zone, consequently, glyphosate deposited on Spartina had more time to penetrate the plant cuticle.

This study found greater control with ground treatment compared to aerial application of Rodeo®. Aerial applications covered only the upper portion of the plant, while ground spraying covered more of the plant.</td></tr>
</table>

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Lessmann, J.M., Mendelssohn, I.A., Hester, M.W., McKee, K.L., 1997. Population variation in growth response to flooding of three marsh grasses. Ecological Engineering 8, 31-47.

Intervention: **Flooding**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

	In a well conducted study…..	***In this study this criterion is:***	
1.1	The study addresses an appropriate and clearly focused question.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.3	If randomised was an adequate concealment method used	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.4	The treatment and control groups are similar at the start of the trial	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.5	The only difference between groups is the treatment under investigation.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.6	All relevant outcomes are measured in a standard, valid and reliable way	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.8	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study? *Also indicate number in each arm of the study, at the time the study began, if given*	Time series flooding experiment of plant samples collected from Louisiana & Texas coasts. Plants were propagated in standardised soils in greenhouse to remove collection site environmental influences.
2.2	What are the main characteristics of the population? *Include all relevant characteristics – e.g. age, sex, health status, location*	*S. patens* & *S. alterniflora*
2.3	If the treatment and control groups are **not** similar at the start of the trial give details of difference here	N/A
2.4	What intervention (treatment, procedure) is being investigated in this study?	Flooding at 7cm above surface level

2.5	What comparisons are made in the study? *Are comparisons made between treatments, or between treatment and control / no treatment group?*	Between different time series
2.6	How long after intervention is the follow-up undertaken in the study?	**0 to 65 days**
2.7	What outcome measure(s) are used in the study?	Redox potential (E_h(mV)) Leaf elongation (cm day^{-1})
2.8	What size of effect is identified in the study? *List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.*	Effect of flooding on leaf elongation rates, averaged over populations, n = 125 *S. alterniflora* n = 95 *S.patens*

Days flooding	*S. alterniflora*	*S.patens*
0		6.0 ± 0.1
15	5.6 ± 0.1	
20		4.1 ± 0.1
30	7.6 ± 0.3	
35		3.5 ± 0.1
45	5.0 ± 0.1	
55		2.7 ± 0.1
65	4.6 ± 0.1	

2.9	How was this study funded?	Louisiana Board of Regents & Louisiana Education Quality Support Fund
2.10	Does this study help to answer your key question? *Summarise the main conclusions of the study and indicate how it relates to the key question.*	Soil conditions were reduced to potentially stressful levels to decrease plant growth. However most shoots elongated rapidly when flooding stress was initiated, suggesting that shoot elongation, rather than leaf elongation, may be a more appropriate variable for measuring differential flood response.

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Linthurst, R.A., 1979. The Effect of Aeration on the Growth of Spartina-Alterniflora Loisel. American Journal of Botany 66, 685-691.

Intervention: **Flooding**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

In a well conducted study…..		***In this study this criterion is:***	
1.1	The study addresses an appropriate and clearly focused question.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.3	If randomised was an adequate concealment method used	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.4	The treatment and control groups are similar at the start of the trial	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable

1.5	The only difference between groups is the treatment under investigation.	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable
1.6	All relevant outcomes are measured in a standard, valid and reliable way	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable
1.7	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study? *Also indicate number in each arm of the study, at the time the study began, if given*	Greenhouse potted Control Trial with 4 different treatments, either Stagnant unaerated (SU), Regularly flooded (RF) Aerated substrate (AS) Stagnant aerated (SA).
2.2	What are the main characteristics of the population? *Include all relevant characteristics – e.g. age, sex, health status, location*	*S. alterniflora*
2.3	If the treatment and control groups are **not** similar at the start of the trial give details of difference here	Stagnant unaerated (SU) flooded to 10cm above substrate surface and left to stagnate. Regularly flooded (RF) diurnal flooding 10cm above to 15cm below substrate. Aerated substrate (AS) flooded to 10cm but water constantly aerated. Stagnant aerated (SA)
2.4	What intervention (treatment, procedure) is being investigated in this study? *List all interventions covered by the study.*	Flooding and water aeration
2.5	What comparisons are made in the study? *Are comparisons made between treatments, or between treatment and control / no treatment group?*	Between different treatments
2.6	How long after intervention is the follow-up undertaken in the study?	5 months
2.7	What outcome measure(s) are used in the study? *List all outcomes that are used to assess effectiveness of the interventions used.*	Density (stems/pot) Aboveground biomass (g/pot) Root biomass (g/pot)
2.8	What size of effect is identified in the study? *List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.*	Measurements of the biological parameters

Treatment	SU	RF	AS	SA
Density (stems/pot)	2.7	6.7	10	7.4
Aboveground biomass (g/pot)	5	15	32	10
Root biomass (g/pot)	7	15	25	10

2.9	How was this study funded?	Carolina Power and Light Company
2.10	Does this study help to answer your key question? *Summarise the main conclusions of the study and indicate how it relates to the key question.*	Density values were not significantly different in the aerated systems but a decreased density in the unaerated system was observed. Both aboveground biomass and belowground biomass were enhanced by the aerated substrate treatment.

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Linthurst, R.A., Seneca, E.D., 1981. Aeration, Nitrogen and Salinity as Determinants of Spartina-Alterniflora Loise - Growth-Response. Estuaries 4, 53-63.

Intervention: **Salinity & Aeration**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

	In a well conducted study…..	***In this study this criterion is:***
1.1	The study addresses an appropriate and clearly focused question.	Well covered / Adequately addressed / Poorly addressed / Not addressed / Not reported / Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered / Adequately addressed / Poorly addressed / Not addressed / Not reported / Not applicable
1.3	If randomised was an adequate concealment method used	Adequately addressed / Not reported
1.4	The treatment and control groups are similar at the start of the trial	Well covered / Adequately addressed / Poorly addressed / Not addressed / Not reported / Not applicable
1.5	The only difference between groups is the treatment under investigation.	Well covered / Adequately addressed / Poorly addressed / Not addressed / Not reported / Not applicable
1.6	All relevant outcomes are measured in a standard, valid and reliable way	Well covered / Adequately addressed / Poorly addressed / Not addressed / Not reported / Not applicable
1.7	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Poorly addressed / Not applicable

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study? *Also indicate number in each arm of the study, at the time the study began, if given*	Randomised Block Design – factorial arrangement of treatments (3 salinities x 2 nitrogen x 2 aerations). Four blocks of 21 treatment combinations per block served as replication. Nitrogen results are not used within this systematic review.
2.2	What are the main characteristics of the population?	*S. alterniflora*
2.3	If the treatment and control groups are **not** similar at the start of the trial give details of difference here	N/A
2.4	What intervention (treatment, procedure) is being investigated in this study? *List all interventions covered by the study.*	Salinity (15‰, 30‰ & 45‰) Nitrogen (0 or 168kg/ha) Aeration (yes/no)

2.5	What comparisons are made in the study?	Between treatments
2.6	How long after intervention is the follow-up undertaken in the study?	3 months
2.7	What outcome measure(s) are used in the study? *List all outcomes that are used to assess effectiveness of the interventions used.*	1) Biomass (g/pot) 2) Density (stems/pot) 3) Mean Height (cm)
2.8	What size of effect is identified in the study? *List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.*	See nested table below
2.9	How was this study funded?	Carolina Power and Light Company
2.10	Does this study help to answer your key question? *Summarise the main conclusions of the study and indicate how it relates to the key question.*	It is apparent that aeration and salinity are determinants for *S. alterniflora* growth. Salinity increases of 15‰ decreased biomass, density and mean height.

Aeration	n	Biomass (g/pot)	Density (stems/pot)	Mean Height (cm)
No	24	11.5	11.2	70.8
Yes	24	26.6	21.8	105.8

Salinity Level	n	Biomass (g/pot)	Density (stems/pot)	Mean Height (cm)
15‰	16	29.0	22.9	107.8
30‰	16	18.4	15.9	90.9
45‰	16	9.8	10.6	66.2

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Lytle, J.S., Lytle, T.F., 1998. Atrazine effects on estuarine macrophytes Spartina alterniflora and Juncus roemerianus. Environmental Toxicology and Chemistry 17, 1972-1978.

Intervention: **Herbicide – Atrazine (a triazine herbicide)**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

In a well conducted study…..		***In this study this criterion is:***
1.1	The study addresses an appropriate and clearly focused question.	Well covered / Adequately addressed / Poorly addressed / Not addressed / Not reported / Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered / Adequately addressed / Poorly addressed / Not addressed / **Not reported** / Not applicable
1.3	If randomised was an adequate concealment method used	Well covered / Adequately addressed / Poorly addressed / Not addressed / **Not reported** / Not applicable
1.4	The treatment and control groups are similar at the start of the trial	**Well covered** / Adequately addressed / Poorly addressed / Not addressed / Not reported / Not applicable
1.5	The only difference between groups is the treatment under investigation.	**Well covered** / Adequately addressed / Poorly addressed / Not addressed / Not reported / Not applicable

1.6	All relevant outcomes are measured in a standard, valid and reliable way	Well covered / Adequately addressed / Poorly addressed / Not addressed / Not reported / Not applicable
1.7	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Well covered / Adequately addressed / Poorly addressed / Not addressed / Not reported / Not applicable

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study? *Also indicate number in each arm of the study, at the time the study began, if given*	Experiment set-up in biochambers contain plants, also includes simulated tides by placing plants in and out of water. Duration of 5 weeks, three pulses of atrazine (at 3 dose lvls) bound to quartz sand were applied.
2.2	What are the main characteristics of the population? *Include all relevant characteristics – e.g. age, sex, health status, location*	*S. alterniflora*
2.3	If the treatment and control groups are **not** similar at the start of the trial give details of difference here	N/A
2.4	What intervention (treatment, procedure) is being investigated in this study? *List all interventions covered by the study.*	Herbicide – Atrazine (2-chloro-4-ethylamino-6-isopropylamine-*s*-triazine) treatments at: 2mg, 20mg, 200mg bound to quartz sand
2.5	What comparisons are made in the study?	Between treatment & control – also treatment v treatment
2.6	How long after intervention is the follow-up undertaken in the study?	7, 14, 21, 28 and 35 days
2.7	What outcome measure(s) are used in the study? *List all outcomes that are used to assess effectiveness of the interventions used.*	Mean shoot elongation (in cm) from 0 to follow-up day
2.8	What size of effect is identified in the study? *List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.*	Shoot elongation (in cm) of *S. alterniflora*

	Control	2mg	20mg	200mg
7 days	2.34± 1	3 ± 0.34	1.9 ± 0.7	0.7 ± 0.3
14 days	3.1 ± 1	5 ± 0.7	2.5 ± 1	3 ± 0.7
21 days	5.1 ± 1.7	6 ± 1	3.8 ± 1.7	7 ± 2
28 days	8.5 ± 2.7	8.6 ± 2	5.7 ± 2.7	10 ± 3
35 days	10 ± 3.4	9.5 ± 2.4	7.1 ± 3.4	10.7 ± 3

2.9	How was this study funded?	US Environment Protection Agency under Cooperate Agreement
2.10	Does this study help to answer your key question? *Summarise the main conclusions of the study and indicate how it relates to the key question.*	Atrazine is a triazine herbicide that inhibits electron transport through photosystemII. It is also the most widely used herbicide in North America (data 1998). Study suggests that *S. alterniflora* is moderately resistant to atrazine.

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Major, W.W., Grue, C.E., Grassley, J.M., Conquest, L.L., 2003. Mechanical and chemical control of smooth cordgrass in Willapa Bay, Washington. Journal of Aquatic Plant Management 41, 6-12.

Intervention: **Mowing, Mowing & Herbicide, Herbicide** (Ground application - Rodeo®), **Herbicide** (Aerial application - Rodeo®)

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

	In a well conducted study…..	***In this study this criterion is:***	
1.1	The study addresses an appropriate and clearly focused question.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.3	If randomised was an adequate concealment method used	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.4	The treatment and control groups are similar at the start of the trial	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.5	The only difference between groups is the treatment under investigation.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.6	All relevant outcomes are measured in a standard, valid and reliable way	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.7	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study? *Also indicate number in each arm of the study, at the time the study began, if given*	Time-series (before & after) across four sites within Willapa Bay, Washington.
2.2	What are the main characteristics of the population?	*S. alterniflora*
2.3	If the treatment and control groups are **not** similar at the start of the trial give details of difference here	No control plot – experiment is a times series with before and after treatments.
2.4	What intervention (treatment, procedure) is	Mowing using hand-held brush cutters to <10cm

<table>
<tr><td></td><td>being investigated in this study?
List all interventions covered by the study.</td><td>Mowing & Herbicide applied after 6 wks.
Herbicide (Ground application) Glyphosate (Rodeo) at 20.2kg a.e./ha in 842 litres water with surfactant at 2%
Herbicide (Aerial application) using helicopter & Glyphosate (Rodeo) at 4.2kg a.e./ha in 93 litres water with surfactant 0.13%</td></tr>
<tr><td>2.5</td><td>What comparisons are made in the study?
Are comparisons made between treatments, or between treatment and control / no treatment group?</td><td>Before and After treatment & comparisons between the study sites.</td></tr>
<tr><td>2.6</td><td>How long after intervention is the follow-up undertaken in the study?</td><td>1 year</td></tr>
<tr><td>2.7</td><td>What outcome measure(s) are used in the study?</td><td>Average % changes in stem density
Average % change in maximum stem height</td></tr>
<tr><td>2.8</td><td>What size of effect is identified in the study?
List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.</td><td>Average % changes in stem density and Average % change in maximum stem height of S. alterniflora pre & post treatment.
<table>
<tr><th>Treatment</th><th>Measure</th><th>Lewis</th><th>Nemah</th><th>North River</th></tr>
<tr><td rowspan="2">Mow</td><td>Stem Density</td><td>-46
99±7, 53±7</td><td>-8
71±4, 65±5</td><td>-68
40±4, 13±3</td></tr>
<tr><td>Stem Height</td><td>-30
54±4, 38±1</td><td>-41
51±2, 30±1</td><td>-62
89±4, 34±4</td></tr>
<tr><td rowspan="2">Spray</td><td>Stem Density</td><td>-82
82±5, 15±6</td><td>-7
56±3, 52±8</td><td>-89
37±2, 4±1</td></tr>
<tr><td>Stem Height</td><td>-73
103±5, 28±3</td><td>-59
80±4, 33±4</td><td>-88
155±5, 14±4</td></tr>
<tr><td rowspan="2">Mow & Spray</td><td>Stem Density</td><td>-94
111±11, 7±2</td><td>-68
76±7, 24±8</td><td>-89
37±6, 4±4</td></tr>
<tr><td>Stem Height</td><td>-78
54±4, 12±2</td><td>-78
58±4, 13±3</td><td>-88
89±6, 11±8</td></tr>
</table>
Stem density 0.25m^2 and max height (cm) within Spartina meadows after aerial application of glyphosate.
<table>
<tr><th></th><th></th><th>Single Appl. (95-96)</th><th>Control</th><th>Repeat Appl. (96-97)</th><th>Single Appl. (96-97)</th></tr>
<tr><td rowspan="2">Pre Treatment</td><td>Stem Density</td><td>47±3</td><td>74±4</td><td>47±3</td><td>99±7</td></tr>
<tr><td>Stem Height</td><td>165±5</td><td>146±3</td><td>165±5</td><td>86±2</td></tr>
<tr><td rowspan="2">Post Treatment</td><td>Stem Density</td><td>61±4</td><td>99±7</td><td>44±3</td><td>67±4</td></tr>
<tr><td>Stem Height</td><td>97±3</td><td>86±2</td><td>14±6</td><td>126±3</td></tr>
<tr><td rowspan="2">% Change</td><td>Stem Density</td><td>30</td><td>34</td><td>-6</td><td>-32</td></tr>
<tr><td>Stem Height</td><td>-41</td><td>-42</td><td>-15</td><td>50</td></tr>
</table></td></tr>
<tr><td>2.9</td><td>How was this study funded?</td><td>WDFW and WDNR</td></tr>
<tr><td>2.10</td><td>Does this study help to answer your key question?
Summarise the main conclusions of the study and indicate how it relates to the key question.</td><td>The results of aerial applications present a management dilemma. While it may be the only treatment for large Spartina infestations, especially those on very soft substrate, it appears not to be efficacious.

Mowing appeared to be the least efficacious, the most labour intensive, and on soft mud sites, the most destructive to the habitat.

Hand spraying, which was similar in efficacy to the mowing plus herbicide combination, appeared to be more efficient, but inconsistent between applicators.</td></tr>
</table>

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Martin, J.L., 2003. The effect of cattle grazing on the abundance and distribution of selected macroinvertebrates in west Galveston Island saltmarsh. MSc Thesis, Texas A&M University, 85 pp.

Intervention: **Herbivory (cattle grazing)**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

	In a well conducted study…..	***In this study this criterion is:***	
1.1	The study addresses an appropriate and clearly focused question.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.3	If randomised was an adequate concealment method used	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.4	The treatment and control groups are similar at the start of the trial	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.5	The only difference between groups is the treatment under investigation.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.6	All relevant outcomes are measured in a standard, valid and reliable way	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.7	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study? *Also indicate number in each arm of the study, at the time the study began, if given*	Control Trial at West End of Galveston Island, Galveston, Texas, USA. Cattle were excluded from areas by fencing control plots. 3 Control and 3 treatment plots were paired.
2.2	What are the main characteristics of the population? *Include all relevant characteristics – e.g. age, sex, health status, location*	*S. alterniflora*
2.3	If the treatment and control groups are **not** similar at the start of the trial give details of difference here	Control plots were fenced to exclude herbivores.
2.4	What intervention (treatment, procedure) is being	Herbivory (cattle grazing – unknown densities)

	investigated in this study?	
2.5	What comparisons are made in the study?	Between control and treatment and between the different parts of the marsh.
2.6	How long after intervention is the follow-up undertaken in the study?	1 year
2.7	What outcome measure(s) are used in the study? *List all outcomes that are used to assess effectiveness of the interventions used.*	Percent cover Stem density (stem/0.5m^2) Maximum height (cm)
2.8	What size of effect is identified in the study? *List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.*	Mean cover, stem density and height of S. alterniflora (mean ± se)

	Percentage %		Stem density		Max heights	
	grazed	not grazed	grazed	not grazed	grazed	not grazed
High tide flats	not present	not present	not present	not present	not present	not present
Edge of marsh	4.7 ± 2.4	14 ± 5.5	90.6 ± 53.8	157.6 ± 61.4	10.8 ± 1.8	26.6 ± 2.1
Upper marsh	46.7 ± 3.9	50.7 ± 6.9	540 ± 60.4	504.2 ± 71.2	32.6 ± 1.0	47.6 ± 2.3
Middle marsh	53.9 ± 6.0	58.8 ± 9.4	569.2 ± 91.0	666.6 ± 107.8	36.5 ± 1.6	45.9 ± 4.6
Lower marsh	85.8 ± 1.7	69.0 ± 6.5	941.6 ± 15.4	687.6 ± 74.6	47.2 ± 1.0	57.3 ± 2.9

2.9	How was this study funded?	M.Sc. thesis
2.10	Does this study help to answer your key question? *Summarise the main conclusions of the study and indicate how it relates to the key question.*	*S. alterniflora* heights were significantly greater for ungrazed versus grazed treatments in the edge, upper, and middle marsh elevation zones. *S. alterniflora* was also significantly taller in the ungrazed lower marsh (versus grazed).

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Mendelssohn, I.A., McKee, K.L., 1988. Spartina-Alterniflora Dieback in Louisiana - Time-Course Investigation of Soil Waterlogging Effects. Journal of Ecology 76, 509-521.

Intervention: **Flooding (water-logging substrate)**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

In a well conducted study…..		***In this study this criterion is:***	
1.1	The study addresses an appropriate and clearly focused question.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.3	If randomised was an adequate concealment method used	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.4	The treatment and control groups are similar at the start of the trial	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable

1.5	The only difference between groups is the treatment under investigation.	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable
1.6	All relevant outcomes are measured in a standard, valid and reliable way	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable
1.7	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study? *Also indicate number in each arm of the study, at the time the study began, if given*	Control Trial conducted near Barataria Bay, Louisiana, USA. Streamside and Inland swards were swapped (transplanted between sites) to see the effects of water-logging.
2.2	What are the main characteristics of the population? *Include all relevant characteristics – e.g. age, sex, health status, location*	*S. alterniflora*
2.3	If the treatment and control groups are **not** similar at the start of the trial give details of difference here	N/A
2.4	What intervention (treatment, procedure) is being investigated in this study? *List all interventions covered by the study.*	Flooding (water-logging of substrate)
2.5	What comparisons are made in the study? *Are comparisons made between treatments, or between treatment and control / no treatment group?*	Between treatment and control
2.6	How long after intervention is the follow-up undertaken in the study?	1 year
2.7	What outcome measure(s) are used in the study? *List all outcomes that are used to assess effectiveness of the interventions used.*	Aboveground biomass (g dry-weight/pot)
2.8	What size of effect is identified in the study? *List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.*	Above-ground biomass one year after transplanted Treatment: g dwt pot Control (stream-stream): 26.43±3.14 inland to streamside (drained): 27.66±2.97 stream to inland (waterlogged): 16.21±2.22 Control (inland-inland): 6.75±0.89
2.9	How was this study funded?	Louisiana Sea Grant Program
2.10	Does this study help to answer your key question? *Summarise the main conclusions of the study and indicate how it relates to the key question.*	Transplantation of streamside *S. alterniflora* swards into more waterlogged and less productive inland marsh significantly reduced swards to their streamside controls

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Norman, C.M., Patten, K., 1997. Cost-Efficacy of Integrated Spartina Control Practices in Willapa Bay, Washington, Second International Spartina Conference, Olympia, WA, U.S.A.

Intervention: **Hand-pulling, Mechanical (mowing), Herbicide (Rodeo/glyphosate) Combined (mow + herbicide)**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

In a well conducted study…..		***In this study this criterion is:***	
1.1	The study addresses an appropriate and clearly focused question.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.3	If randomised was an adequate concealment method used	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.4	The treatment and control groups are similar at the start of the trial	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.5	The only difference between groups is the treatment under investigation.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.6	All relevant outcomes are measured in a standard, valid and reliable way	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.7	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study?	A number of Control trials and time series experiments conducted in Willapa Bay, Washington, USA.
2.2	What are the main characteristics of the population?	*S. alterniflora*
2.3	If the treatment and control groups are **not** similar at the start of the trial give details of difference here	N/A
2.4	What intervention (treatment, procedure) is being investigated in this study? *List all interventions covered by the study.*	Hand-pulling, Mechanical (mowing with a hand-held weed whacker), Herbicide (Rodeo/glyphosate) Combined (mow + herbicide)
2.5	What comparisons are made in the study?	Between treatments and treatment & control
2.6	How long after intervention is the follow-up?	4 to 11 months
2.7	What outcome measure(s) are used in the study?	Percentage Kill

2.8	What size of effect is identified in the study? *List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.*	Cost-efficacy of hand-pulling Spartina

		% Kill	
Month ('95)	$ stem	Sept'95	Apr'96
May	4	99	97
June	7	100	
July	12	100	100

Cost-efficacy of continuous mowing treatments

		% kill	
	No. of mows	Apr'96	$/acre
Control	0	0	0
Early'95	4	92	469
Mid'95	3	99	346
Late'95	2	95	312

Cost-efficacy of combined mowing and Rodeo treatments

	No. of mows	Rodeo Qt/acre	% kill (1 year)	$/acre
Control	0	0	0	0
Early'95	3	6.5	100	637
Mid'95	2	3.5	98	431
Late'95	1	4.8	97	456

Cost-efficacy of hand-held wiping or spraying Rodeo treatments

Method	Appl'n Date	Rodeo Qt/acre	% kill (1 year)	$/acre
Control		0	0	0
Wipe	Jun'94	8.3	91	310
Spray	Jun'95	18.0	81	585

Summary of most cost-effective, integrated Spartina management practices

Method	% kill	Acreage	$/acre
Mow only	95	low	312
Mow + Rodeo	98	low	431
Rodeo hand wipe	91	low	310
Rodeo hand spray	81	low	585
Rodeo aerial	?	high	165

2.9	How was this study funded?	Not reported

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Olmstead, K.L., Denno, R.F., Morton, T.C., Romeo, J.T., 1997. Influence of Prokelisia planthoppers on amino acid composition and growth of Spartina alterniflora. Journal of Chemical Ecology 23, 303-321.

Intervention: **Hervivory (*Prokelisia dolus* – a planthopper)**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

In a well conducted study…..		***In this study this criterion is:***
1.1	The study addresses an appropriate and clearly focused question.	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable

1.3	If randomised was an adequate concealment method used	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable
1.4	The treatment and control groups are similar at the start of the trial	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable
1.5	The only difference between groups is the treatment under investigation.	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable
1.6	All relevant outcomes are measured in a standard, valid and reliable way	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable
1.7	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study? *Also indicate number in each arm of the study, at the time the study began, if given*	Greenhouse control trial with 3 x 2 x 2 factorial design with planthoppers (present, absent, caged control), N-fertiliser (low or high) feeding duration (9 & 15 days). Each treatment replicated 10 times.
2.2	What are the main characteristics of the population? *Include all relevant characteristics – e.g. age, sex, health status, location*	*S. alterniflora*
2.3	If the treatment and control groups are **not** similar at the start of the trial give details of difference here	N/A
2.4	What intervention (treatment, procedure) is being investigated in this study? *List all interventions covered by the study.*	**Hervivory** (*Prokelisia dolus* – a planthopper) density of 200 for treatment cages
2.5	What comparisons are made in the study? *Are comparisons made between treatments, or between treatment and control / no treatment group?*	Between treatment and control
2.6	How long after intervention is the follow-up undertaken in the study? *Length of time subjects is followed, from beginning participation in the study. Note specified end points used to decide end of follow-up (e.g. death, complete cure). Note if follow-up period is shorter than originally planned and reason (if given).*	9 and 15 days
2.7	What outcome measure(s) are used in the study? *List all outcomes that are used to assess effectiveness of the interventions used.*	Average number of new leaves/stem Tiller elongation (cm) Average number of dead leaves/stem
2.8	What size of effect is identified in the study? *List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.*	Effects of planthoppers on *Spartina*

	New Leaves/stem	Tiller elongation	Dead leaves/stem
Control	0.75±0.12	7.9±0.8	1.4±0.2
Treatment	0.25±0.06	5.2±0.4	2.4±0.2

2.9	How was this study funded?	National Science Foundation grant
2.10	Does this study help to answer your key question? *Summarise the main conclusions of the study and indicate how it relates to the key question.*	The available surface area of plant was reduced as a consequence of a decrease in culm and tiller elongation, production of new leaves, and an increase in leaf mortality associated with planthopper feeding.

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Partridge, T.R., Wilson, J.B., 1987. Salt tolerance of salt marsh plants of Otago, New Zealand, New Zealand Journal of Botany. 25:559-566.

Intervention: **Salinity**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

In a well conducted study…..		***In this study this criterion is:***	
1.1	The study addresses an appropriate and clearly focused question.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.3	If randomised was an adequate concealment method used	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.4	The treatment and control groups are similar at the start of the trial	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.5	The only difference between groups is the treatment under investigation.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.6	All relevant outcomes are measured in a standard, valid and reliable way	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.7	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study? *Also indicate number in each arm of the study, at the time the study began, if given*	Greenhouse control trial to assess the salt tolerance of 31 various plant species. Replication of 4 plants per species.
2.2	What are the main characteristics of the population? *Include all relevant characteristics – e.g. age, sex, health status, location*	*S. anglica*

<table>
<tr><td>2.3</td><td>If the treatment and control groups are <u>not</u> similar at the start of the trial give details of difference here</td><td>N/A</td></tr>
<tr><td>2.4</td><td>What intervention (treatment, procedure) is being investigated in this study?
List all interventions covered by the study.</td><td>Salinity
(0% to 5% with 3% approx seawater)</td></tr>
<tr><td>2.5</td><td>What comparisons are made in the study?
Are comparisons made between treatments, or between treatment and control / no treatment group?</td><td>Between differing salinities</td></tr>
<tr><td>2.6</td><td>How long after intervention is the follow-up undertaken in the study?</td><td>1 year</td></tr>
<tr><td>2.7</td><td>What outcome measure(s) are used in the study?
List all outcomes that are used to assess effectiveness of the interventions used.</td><td>Live shoot dry weight as % of total shoot dry weight</td></tr>
<tr><td>2.8</td><td>What size of effect is identified in the study?
List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.</td><td>Live shoot dry weight as % of total shoot dwt of S. anglica
<table>
<tr><td>Salinity</td><td>%</td></tr>
<tr><td>0</td><td>79</td></tr>
<tr><td>0.25</td><td>90</td></tr>
<tr><td>0.5</td><td>99</td></tr>
<tr><td>1.0</td><td>87</td></tr>
<tr><td>1.5</td><td>71</td></tr>
<tr><td>2.0</td><td>75</td></tr>
<tr><td>2.5</td><td>71</td></tr>
<tr><td>3.0</td><td>59</td></tr>
<tr><td>3.5</td><td>59</td></tr>
<tr><td>5.0</td><td>0</td></tr>
</table></td></tr>
<tr><td>2.9</td><td>How was this study funded?</td><td>Not reported</td></tr>
<tr><td>2.10</td><td>Does this study help to answer your key question?
Summarise the main conclusions of the study and indicate how it relates to the key question.</td><td>S. anglica growth is suppressed by freshwater and by the highest salinities. Of all the plants tested S. anglica had the widest range of salinity survival in relation to growth.</td></tr>
</table>

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Patten, K. (2004) Comparison of chemical and mechanical control efforts for invasive Spartina in Willapa Bay, WA.

Intervention: **Herbicide (Glyphosate & Imazapyr) Mechanical Control (Crushing, tilling & disking) Combined**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

In a well conducted study…..		***In this study this criterion is:***	
1.1	The study addresses an appropriate and clearly focused question.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.3	If randomised was an adequate concealment method used	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable

1.4	The treatment and control groups are similar at the start of the trial	Well covered / Adequately addressed / Poorly addressed / Not addressed / Not reported / Not applicable
1.5	The only difference between groups is the treatment under investigation.	Well covered / **Adequately addressed** / Poorly addressed / Not addressed / Not reported / Not applicable
1.6	All relevant outcomes are measured in a standard, valid and reliable way	**Well covered** / Adequately addressed / Poorly addressed / Not addressed / Not reported / Not applicable
1.7	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Well covered / **Adequately addressed** / Poorly addressed / Not addressed / Not reported / Not applicable

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study?	Site comparison each of varying area (without controls) across Willapa Bay, Washington, USA.
2.2	What are the main characteristics of the population?	S. alterniflora
2.3	If the treatment and control groups are not similar at the start of the trial give details of difference here	Differing substrates at each site
2.4	What intervention (treatment, procedure) is being investigated in this study?	**Herbicide** (Glyphosate & Imazapyr) **Mechanical Control** (Tilling / Crushing / Disking) **Crushing & Herbicide**
2.5	What comparisons are made in the study?	Between each treatment
2.6	How long after intervention is the follow-up undertaken in the study?	1 year
2.7	What outcome measure(s) are used in the study? *List all outcomes that are used to assess effectiveness of the interventions used.*	Percent *Spartina* free quadrats Percent control Stem density/0.25m2
2.8	What size of effect is identified in the study? *List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.*	Percent *Spartina* free quadrats from differing control methods

Treatment	Mean
Crushing (2 years)	38
Crushing (1 year)	35
Crushing & Glyphosate 38kg/ha (2 years)	68
Crushing & Glyphosate 38kg/ha (1 year)	58
Glyphosate 38kg/ha (2 years)	61
Glyphosate 38kg/ha (1 year)	57
Glyphosate 9kg/ha (1 year)	32
Percent control with differing herbicide	
Imazapyr 1.7kg/ha	87.5
Glyphosate 18kg/ha	81.5

Data presented for each site giving stem density in Appendix (table 1-3) also extracted.

2.9	How was this study funded?	Willapa National Wildlife Refuge & Washington State Commission for Pesticide Registration.
2.10	Does this study help to answer your key question? *Summarise the main conclusions of the study and indicate how it relates to the key question.*	Tilling although a superlative method for mechanical control is costly, requiring an expensive ($250,000) amphibious tiller and is slow (~0.25ha/hr). It also has a limited window during winter when it works and unless it is preceded by summer mowing results in massive seedling density of more than 200 seedlings/m^2. Crushing is relatively less expensive (~$40,000-80,000)

		for equipment and is faster (1-2ha/hr) than tilling but requires multiple crushing events per year. However is very effective on soft sediments. The broadcast rate of gylphosate, although inexpensive only provides control under ideal conditions (>48hr drying time and clean canopy) which rarely occurs. Imazapyr was relatively inexpensive ($600/ha), fast (>100ha/day) and fairly efficacious. With the exceptions of tilling and imazapyr, no control method provided efficacy near the required to achieve eradication in a reasonable time frame of repeated years of control.

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)
Patten, K., 2006. Managing Spartina with glyphosate and imazapyr, Aquatic invasive conference.

Intervention**: Herbicide (Glyphosate & Imazapyr)**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

In a well conducted study…..		***In this study this criterion is:***	
1.1	The study addresses an appropriate and clearly focused question.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.3	If randomised was an adequate concealment method used	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.4	The treatment and control groups are similar at the start of the trial	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.5	The only difference between groups is the treatment under investigation.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.6	All relevant outcomes are measured in a standard, valid and reliable way	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.7	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY ***(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).***		
2.1	What is the experimental design used in this study? *Also indicate number in each arm of the study, at the time the study began, if given*	Site comparison, each of varying area (without controls) across Willapa Bay, Washington, USA.
2.2	What are the main characteristics of the population?	S. alterniflora
2.3	If the treatment and control groups are **not** similar at the start of the trial give details of difference here	Differing substrates at each site
2.4	What intervention (treatment, procedure) is being investigated in this study?	**Herbicide** Glyphosate (4.2 kg ae/ha, 8.4 kg ae/ha, 18 kg ae/ha) Imazapyr (0.84 kg ae/ha, 1.68 kg ae/ha)
2.5	What comparisons are made in the study?	Between the different treatments
2.6	How long after intervention is the follow-up undertaken in the study?	1 year
2.7	What outcome measure(s) are used in the study?	Percent control compared to untreated area
2.8	What size of effect is identified in the study? *List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.*	Percent control compared to untreated area Treatment: % control Imazapyr (0.84 kg ae/ha): 50 Imazapyr (1.68 kg ae/ha): 95 Glyphosate (4.2 kg ae/ha): 10 Glyphosate (8.4 kg ae/ha): 46 Glyphosate (18 kg ae/ha): 90
2.9	How was this study funded?	Washington State Commission on Pesticide Regulations
2.10	Does this study help to answer your key question? *Summarise the main conclusions of the study and indicate how it relates to the key question.*	Imazapyr was a more effective for controlling Spartina across the range of estuary conditions than glyphosate. Effective rates (ae/ha) for imazapyr were 1/10 those of glyphosate and took a shorter dry time then glysophate. The use of imazapyr is significantly more cost effective than glyphosate.

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Patten, K., 2002. Smooth cordgrass (Spartina alterniflora) control with imazapyr. Weed Technology 16, 826-832.

also listed as: Patten (2002a) in summary tables

Intervention: **Herbicide (Imazapyr, Glyphosate, Clethodim & Fluazifop-p)**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY		
In a well conducted study…..		***In this study this criterion is:***
1.1	The study addresses an appropriate and clearly focused question.	Well covered / Adequately addressed / Poorly addressed / Not addressed / Not reported / Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered / Adequately addressed / Poorly addressed / Not addressed / Not reported / Not applicable

1.3	If randomised was an adequate concealment method used	Well covered / Adequately addressed / Poorly addressed / Not addressed / Not reported / Not applicable
1.4	The treatment and control groups are similar at the start of the trial	Well covered / **Adequately addressed** / Poorly addressed / Not addressed / Not reported / Not applicable
1.5	The only difference between groups is the treatment under investigation.	Well covered / **Adequately addressed** / Poorly addressed / Not addressed / Not reported / Not applicable
1.6	All relevant outcomes are measured in a standard, valid and reliable way	**Well covered** / Adequately addressed / Poorly addressed / Not addressed / Not reported / Not applicable
1.7	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	**Well covered** / Adequately addressed / Poorly addressed / Not addressed / Not reported / Not applicable

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study? Also indicate number in each arm of the study, at the time the study began, if given	Multiple Randomised Block design experiments on the efficacy of differing herbicides. Undertaken in Willapa Bay, Washington, USA.
2.2	What are the main characteristics of the population?	S. alterniflora
2.3	If the treatment and control groups are **not** similar at the start of the trial give details of difference here	N/A
2.4	What intervention (treatment, procedure) is being investigated in this study? *List all interventions covered by the study.*	**Herbicide** at varying rates (see below) **(Imazapyr, Glyphosate, Clethodim & Fluazifop-p)**
2.5	What comparisons are made in the study? Are comparisons made between treatments, or between treatment and control / no treatment group?	Between treatment & control and between treatments
2.6	How long after intervention is the follow-up undertaken in the study?	Varies with experiment either 1 year or 10/15 months
2.7	What outcome measure(s) are used in the study?	Percent control Density - Shoot/m^2
2.8	What size of effect is identified in the study? *List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.*	**Effects of herbicide on *S.alterniflora*** **Herbicide rate & spray volume**

Effects of herbicide on *S.alterniflora*

Treatment	Rate (kg/ha)	Site 1	Site 2
Clethodim	0.73	50	68
Fluazifop-p	0.36	87	90
Imazapyr	1.68	98	86
Glyphosate	18.00		87
Control	0	0	0

Herbicide rate & spray volume

Treatment	Rate (kg/ha)	vol. (L/ha)	Site 1 % control	Site 2 % control	Site 1 Shoot/m^2	Site 2 Shoot/m^2
Imazapyr	0.84	94	47	16	128	98
	0.84	183	84	48	3	71
	0.84	374	93	27	2	83
	1.68	94	84	56	4	50
	1.68	183	95	71	1	24
	1.68	374	94	92	0	1

		Glyphosate	3.63	374	36	10	53	126
			7.26	748	70	-	7	-
		Control	0	0	0	0	215	172
		Data also extracted from tables 4 (spray date), & 6 (surfactant type)						
2.9	How was this study funded?	Washington State Commission on Pesticide Regulations						
2.10	Does this study help to answer your key question? *Summarise the main conclusions of the study and indicate how it relates to the key question.*	Clethodim was not very effective at controlling *S. alterniflora*. Control using imazapyr improved with increased rates of a.e/ha and was best with spray rates of greater than 0.94 l/ha. The effects of spray date on imazapyr efficacy were influenced by spray volume. Least effective dates were July and October. Because of concerns about toxicity to non-target aquatic organisms, the use of surfactant is an important issue. By showing similar control across surfactants, product selection for this use can be made on the basis of risk reduction to non-target aquatic organisms.						

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)
Patten, K., 2002. The efficacy of mechanical treatment efforts in 2001 on the control of spartina in willapa bay in 2002, The Willapa National Wildlife Refuge.
also listed as: Patten (2002b) in summary tables

Intervention: **Mechanical control (Tilling, Disking, Crushing and Combinations)**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

In a well conducted study…..		***In this study this criterion is:***	
1.1	The study addresses an appropriate and clearly focused question.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.3	If randomised was an adequate concealment method used	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.4	The treatment and control groups are similar at the start of the trial	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.5	The only difference between groups is the treatment under investigation.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.6	All relevant outcomes are measured in a standard, valid and reliable way	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.7	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study?	Site comparison with control plots at each site for the main experiment. Undertaken at sites across Willapa Bay, Washington, USA.
2.2	What are the main characteristics of the population?	S. alterniflora
2.3	If the treatment and control groups are not similar at the start of the trial give details of difference here	N/A
2.4	What intervention (treatment, procedure) is being investigated in this study?	Mechanical control see original study for details of treatments and machinery used (Tilling, Disking, Crushing and Combinations)
2.5	What comparisons are made in the study?	Between treatments and control
2.6	How long after intervention is the follow-up undertaken in the study?	Follow-up varies with site (6 months to 2 years dependant on treatment)
2.7	What outcome measure(s) are used in the study? List all outcomes that are used to assess effectiveness of the interventions used.	Mean stem density/0.25m2 Plant height (m)
2.8	What size of effect is identified in the study?	Effect of No. of crushing/pulverizing passes with Marsh Master in winter on Spartina

Treatment	Mean Stem Density/m^2
One pass	64.5 ± 14.6
Two passes	87.8 ± 11.8
Three passes	44.7 ± 9.1
Four passes	24.3 ± 4.3
Five passes	29.8 ± 3.9
Six passes	10.8 ± 5.2

Mechanical control on Spartina characteristics

	Number stems/0.25^2		Plant Ht (m)	
Treatment	Treatment	Control	Treatment	Control
Winter Tilling	1.5 ± 0.3	80.9 ± 4.4	0.4 ± 0.1	1.4 ± 0.2
Winter Tilling/Disk	3.2 ± 0.7	80.9 ± 4.4	0.4 ± 0.1	1.4 ± 0.2
Tandem Disk (Dec/Jan)	3.8 ± 1.2	102.2 ± 7.9	0.6 ± 0.2	0.9 ± 0.6
Tandem Disk (Feb)	18.4 ± 2.3	81.2 ± 5.6	0.4 ± 0.2	0.8 ± 0.4
Crushing Marsh Master (Summer)	46.9 ± 3.2	52.5 ± 4.2	1.2 ± 0.6	1.5 ± 0.3
Crushing/ Pulverize (Winter)	26.0 ± 3.4	108.1 ± 5.6	0.6 ± 0.3	
Crushing/ Pulverize (Winter)	71.7 ± 6.8	108.1 ± 5.6	0.6 ± 0.3	
Crushing with Bombardier	6.16 ± 0.6	80.0 ± 3.9	0.9	1.01

2.9	How was this study funded?	US Fish & Wildlife Service
2.10	Does this study help to answer your key question? *Summarise the main conclusions of the study and indicate how it relates to the key question.*	Mechanical control can be effectively used to help in managing Spartina swards, however, manage and eradication are two different issues. All methods were problematic whether the coast of equipment or slow rate of treatment (< 1-2ha/hr).

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Pezeshki, S.R., Delaune, R.D., 1997. Population differentiation in Spartina patens: Responses of photosynthesis and biomass partitioning to elevated salinity. Botanical Bulletin of Academia Sinica 38, 115-120.

Intervention: **Salinity**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

In a well conducted study…..		***In this study this criterion is:***	
1.1	The study addresses an appropriate and clearly focused question.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.3	If randomised was an adequate concealment method used	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.4	The treatment and control groups are similar at the start of the trial	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.5	The only difference between groups is the treatment under investigation.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.6	All relevant outcomes are measured in a standard, valid and reliable way	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.7	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study? *Also indicate number in each arm of the study, at the time the study began, if given*	Randomized Control Trial greenhouse experiment using natural light. Plants were grown in pots with uniform substrate – treatment started 4 weeks after transplanting. Each treatment replicated 64 times (pots)
2.2	What are the main characteristics of the population? *Include all relevant characteristics – e.g. age, sex, health status, location*	*S. patens* samples (60-100) from 3 different sites, one a brackish high salinity population (Ferblanc), one freshwater/ brackish zone (Clovelly), one brackish saltmarsh (Lake Tambour) these were cloned in greenhouse.
2.3	If the treatment and control groups are **not** similar at the start of the trial give details of difference here	As above – 3 different locations for starting samples
2.4	What intervention is being investigated in this study?	Salinity 0ppt (control), 5ppt, 15ppt

2.5	What comparisons are made in the study? *Are comparisons made between treatments, or between treatment and control / no treatment group?*	Between control and treatments and between treatments
2.6	How long after intervention is the follow-up undertaken in the study?	3 months (84 days)
2.7	What outcome measure(s) are used in the study? *List all outcomes that are used to assess effectiveness of the interventions used.*	1) Number of shoots/per pot 2) Leaf area/per pot 3) Dry Weight/per pot
2.8	What size of effect is identified in the study? *List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.*	Change in characteristics (final value minus initial values) of *S.patens*

	Dry Weight	Leaf Area	No. of shoots
Ferblanc	11	0.04	30
Clovelly	25	0.08	22
Lake Tambour	19	0.06	28

2.9	How was this study funded? *List all sources of funding quoted in the article, whether Government, voluntary sector, or industry.*	Louisiana Education Quality Support Fund
2.10	Does this study help to answer your key question? *Summarise the main conclusions of the study and indicate how it relates to the key question.*	The observed responses of the study populations to elevated salinities could be partially explained in light of field observations which indicates that two populations are associated with high salinities characteristic of a brackish-saltmarsh zone, while the remaining population occupies the less saline environment of freshwater-brackish marsh zone.

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Ranwell, D.S., 1961. Spartina Salt Marshes in Southern England: I. The Effects of Sheep Grazing at the Upper Limits of Spartina Marsh in Bridgwater Bay. The Journal of Ecology 49, 325-340.

Intervention: **Herbivory (Sheep)**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

In a well conducted study…..		***In this study this criterion is:***	
1.1	The study addresses an appropriate and clearly focused question.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.3	If randomised was an adequate concealment method used	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.4	The treatment and control groups are similar at the start of the trial	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable

1.5	The only difference between groups is the treatment under investigation.	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable
1.6	All relevant outcomes are measured in a standard, valid and reliable way	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable
1.8	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study? *Also indicate number in each arm of the study, at the time the study began, if given*	Two sites with replicated plot layout. Each plot measured 0.01 ha. Each experiment was a crossover design with two treatments and four replicates (four plots ungrazed, four ungrazed).
2.2	What are the main characteristics of the population? *Include all relevant characteristics – e.g. age, sex, health status, location*	*Spartina* (incorrectly ID'ed as *S. townsendii* but most likely *S. anglica*)
2.3	If the treatment and control groups are **not** similar at the start of the trial give details of difference here	
2.4	What intervention (treatment, procedure) is being investigated in this study? *List all interventions covered by the study.*	(Herbivory) Sheep Grazing
2.5	What comparisons are made in the study? *Are comparisons made between treatments, or between treatment and control / no treatment group?*	Between treatment and control
2.6	How long after intervention is the follow-up undertaken in the study?	Annually in June (1-5 years after the initial treatment)
2.7	What outcome measure(s) are used in the study? *List all outcomes that are used to assess effectiveness of the interventions used.*	Percent composition per plot (0.01ha)
2.8	What size of effect is identified in the study? *List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.*	Percent composition per plot (0.01ha) of *Spartina*

	1955		1957	
	mean	sd	mean	sd
Treatment	90.2	3.1	92.4	5.6
Control	84.6	9.6	39.6	42.9

2.9	How was this study funded?	Details not reported
2.10	Does this study help to answer your key question? Summarise the main conclusions of the study and indicate how it relates to the key question.	Sheep actually graze *Spartina* and apparently on the upper limits of salt-marsh sheep are often capable of slowing down the vegetative propagation of *Spartina* but they do not prevent the spreading of the species. Moreover, it seems possible that the degree of *Spartina* grazing depends on the extent to which other grasses occur. The rate of change of upper limits of a marsh in which *Spartina* is dominant, to a predominantly *Phagmites* marsh (ungrazed) or to a *Puccinellia* marsh (grazed) is estimated to be of the order of 8 and 10 years respectively in this area.

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Reimold, R.J., Linthurst, R.A., Wolf, P.L., 1975. Effects of grazing on a salt marsh. Biological Conservation 8, 105-125.

Intervention: **Herbivory (ungulates – sheep/cattle/horse)**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

In a well conducted study…..		***In this study this criterion is:***	
1.1	The study addresses an appropriate and clearly focused question.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.3	If randomised was an adequate concealment method used	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.4	The treatment and control groups are similar at the start of the trial	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.5	The only difference between groups is the treatment under investigation.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.6	All relevant outcomes are measured in a standard, valid and reliable way	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.7	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study? *Also indicate number in each arm of the study, at the time the study began, if given*	Site Comparison (across 3 sites) One that had been grazed for 30 years, one taken out of grazing and another ungrazed. Five replicates are undertaken to calculate the means
2.2	What are the main characteristics of the population?	*S. alterniflora*
2.3	If the treatment and control groups are **not** similar at the start of the trial give details of difference here	
2.4	What intervention (treatment, procedure) is being investigated in this study?	Herbivory (ungulates – sheep/cattle/horse & simulated grazing)
2.5	What comparisons are made in the study?	Treatment v control and between treatments
2.6	How long after intervention is the follow-up?	4 to 8 months

<table>
<tr><td>2.7</td><td>What outcome measure(s) are used in the study?
List all outcomes that are used to assess effectiveness of the interventions used.</td><td>1) Mean wet weight (g/m2)
2) Mean dry weight (g/m2)
3) Number of stems (m^2)</td></tr>
<tr><td>2.8</td><td>What size of effect is identified in the study?
List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.</td><td>Comparison of the three treatments
<table>
<tr><td></td><td>Mean wet weight (g/m2)</td><td>Mean dry weight (g/m2)</td><td>% dry weight</td></tr>
<tr><td>Ungrazed (alive)</td><td>474.4</td><td>168.1</td><td>35.4</td></tr>
<tr><td>Ungrazed (dead)</td><td>326.2</td><td>129.5</td><td>39.7</td></tr>
<tr><td>Grazed (alive)</td><td>269.7</td><td>95.1</td><td>35.3</td></tr>
<tr><td>Grazed (dead)</td><td>147.1</td><td>53.0</td><td>36.0</td></tr>
<tr><td>Formerly grazed (alive)</td><td>314.5</td><td>95.0</td><td>30.2</td></tr>
<tr><td>Formerly grazed (dead)</td><td>353.0</td><td>89.6</td><td>25.4</td></tr>
</table>
Comparison of the simulated grazing treatment over time
<table>
<tr><td></td><td colspan="2">Number of stems (m^2)</td><td colspan="2">Mean dry weight (g/m2)</td></tr>
<tr><td></td><td>mean</td><td>se</td><td>mean</td><td>se</td></tr>
<tr><td>Control</td><td>187.6</td><td>4.1</td><td>287.3</td><td>28.9</td></tr>
<tr><td>4 months</td><td>198.2</td><td>20.0</td><td>327.5</td><td>25.5</td></tr>
<tr><td>6 months</td><td>270.2</td><td>57.2</td><td>203.6</td><td>28.2</td></tr>
<tr><td>8 months</td><td>318.0</td><td>47.6</td><td>228.2</td><td>30.0</td></tr>
</table></td></tr>
<tr><td>2.9</td><td>How was this study funded?</td><td>National Oceanic and Atmospheric Administration & Office of Sea Grant</td></tr>
<tr><td>2.10</td><td>Does this study help to answer your key question?
Summarise the main conclusions of the study and indicate how it relates to the key question.</td><td>Grazing of salt marshes by ungulates has a significant impact on the ecosystem. Primary production, detritus production and invertebrate (crab) fauna are all reduced by grazing.</td></tr>
</table>

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Seliskar, D.M., 2003. The response of Ammophila breviligulata and Spartina patens (Poaceae) to grazing by feral horses on a dynamic mid-Atlantic barrier island. American Journal of Botany 90, 1038-1044.

Intervention: **Herbivory (feral horses)**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

In a well conducted study…..		***In this study this criterion is:***	
1.1	The study addresses an appropriate and clearly focused question.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.3	If randomised was an adequate concealment method used	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.4	The treatment and control groups are similar at the start of the trial	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable

1.5	The only difference between groups is the treatment under investigation.	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable
1.6	All relevant outcomes are measured in a standard, valid and reliable way	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable
1.7	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study? *Also indicate number in each arm of the study, at the time the study began, if given*	Control trial with the plots selection was based on dune morphology. The effects of grazing were assessed using a series of paired plots, one fenced and the other open. Replication was 2 plots across the dunes.
2.2	What are the main characteristics of the population? *Include all relevant characteristics – e.g. age, sex, health status, location*	*S. patens* Feral horses (approx 160-170)
2.3	If the treatment and control groups are **not** similar at the start of the trial give details of difference here	
2.4	What intervention (treatment, procedure) is being investigated in this study? *List all interventions covered by the study.*	**Herbivory (feral horses)**
2.5	What comparisons are made in the study?	Between treatment and control
2.6	How long after intervention is the follow-up undertaken in the study?	1 year
2.7	What outcome measure(s) are used in the study? *List all outcomes that are used to assess effectiveness of the interventions used.*	Percent cover Plant height (cm) Leaf length (cm) Stem diameter (mm) Stem density (no. stem/m^2) Aboveground shoot biomass (g/m^2) Percent plants in flower Root & rhizome biomass (g/m^2)
2.8	What size of effect is identified in the study? *List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.*	Characteristics of S. patens between treatment and control

	Treatment		Control	
	mean	se	mean	se
Percent cover	1.6	0.7	5.2	0.5
Plant height (cm)	23.9	0.1	32.6	3.2
Leaf length (cm)	17.0	1.2	20.9	3.4
Stem diameter (mm)	1.7	0.1	2.3	0.1
Stem density (no. stem/m^2)	35.0	4.8	43.0	4.7
Aboveground shoot biomass (g/m^2)	7.7	3.4	27.1	2.0
Percent plants in flower	0.0	0.0	41.5	21.5

		Root & rhizome biomass (g/m^2)	4.3	2.1	19.4	5.6
2.9	How was this study funded?	National Park Service				
2.10	Does this study help to answer your key question? *Summarise the main conclusions of the study and indicate how it relates to the key question.*	Grazing is detrimental to the growth and spread *S. patens*				

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Silliman, B.R., Zieman, J.C., 2001. Top-down control of *Spartina alterniflora* production by periwinkle grazing in a Virginia salt marsh. Ecology 82, 2830-2845.

Intervention: **Herbivory (*Littoraria irrorata* - periwinkle)**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

In a well conducted study…..		***In this study this criterion is:***	
1.1	The study addresses an appropriate and clearly focused question.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.3	If randomised was an adequate concealment method used	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.4	The treatment and control groups are similar at the start of the trial	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.5	The only difference between groups is the treatment under investigation.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.6	All relevant outcomes are measured in a standard, valid and reliable way	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.7	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study? *Also indicate number in each arm of the study, at the time the study began, if given*	A 2x3 factorial designed control trial with two levels of nitrogen (*not used for this review*) and three levels of grazer density (0, ambient of 48 per m^2, 3x ambient). Experiment undertaken in Virginia, USA
2.2	What are the main characteristics of the population?	*S. alterniflora*

<table>
<tr><td></td><td></td><td>Littoraria irrorata – a periwinkle</td></tr>
<tr><td>2.3</td><td>If the treatment and control groups are <u>not</u> similar at the start of the trial give details of difference here</td><td>N/A</td></tr>
<tr><td>2.4</td><td>What intervention (treatment, procedure) is being investigated in this study?</td><td>Herbivory (Littoraria irrorata - periwinkle)</td></tr>
<tr><td>2.5</td><td>What comparisons are made in the study?</td><td>Between treatments and control</td></tr>
<tr><td>2.6</td><td>How long after intervention is the follow-up undertaken in the study?</td><td>4 months</td></tr>
<tr><td>2.7</td><td>What outcome measure(s) are used in the study?
List all outcomes that are used to assess effectiveness of the interventions used.</td><td>Stem biomass (g)
Stem height (cm)
No. of dead leaves/stem
Standing crop (g/m^2)</td></tr>
<tr><td>2.8</td><td>What size of effect is identified in the study?
List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.</td><td>Effects of periwinkle grazing on stem structure and standing crop of S. alterniflora
<table>
<tr><td></td><td colspan="2">Control</td><td colspan="2">Natural</td><td colspan="2">Natural x3</td></tr>
<tr><td></td><td>mean</td><td>se</td><td>mean</td><td>se</td><td>mean</td><td>se</td></tr>
<tr><td>Stem biomass (g)</td><td>1.3</td><td>0.11</td><td>1.1</td><td>0.19</td><td>0.7</td><td>0.08</td></tr>
<tr><td>Stem height (cm)</td><td>56.8</td><td>4.26</td><td>55.2</td><td>1.89</td><td>52.2</td><td>3.05</td></tr>
<tr><td>No. of dead leaves/stem</td><td>2.1</td><td>0.26</td><td>2.9</td><td>0.24</td><td>4.0</td><td>0.31</td></tr>
<tr><td>Standing crop (g/m^2)</td><td>231</td><td>28.4</td><td>155</td><td>14.8</td><td>51</td><td>15.8</td></tr>
</table></td></tr>
<tr><td>2.9</td><td>How was this study funded?</td><td>National Science Foundation, the Virginia Coast Reserve Long Term Ecological Research project, the Nature Conservancy, & the Odum Foundation.</td></tr>
<tr><td>2.10</td><td>Does this study help to answer your key question?
Summarise the main conclusions of the study and indicate how it relates to the key question.</td><td>Based on studies results, two inferences made: (1) snails may facilitate microbial infection of live plant tissue (2) snails graze live Spartina even when standing-dead material is available.</td></tr>
</table>

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Taylor, M.C., Burrows, E.M., 1968. Chemical control of fertile Spartina townsendii (S.L.) on the Cheshire shore of the Dee Estuary: 1. Field Trials on Spartina sward. Weed Research 8, 170-184.

Also referred to: **Taylor & Burrows (1968a)**

Intervention: **Herbicide (Dalapon, Paraquat, Fenuron, Bromacil, Amitrole-T)**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

In a well conducted study…..		***In this study this criterion is:***	
1.1	The study addresses an appropriate and clearly focused question.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.3	If randomised was an adequate concealment method used	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable

1.4	The treatment and control groups are similar at the start of the trial	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable
1.5	The only difference between groups is the treatment under investigation.	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable
1.6	All relevant outcomes are measured in a standard, valid and reliable way	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable
1.7	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study? *Also indicate number in each arm of the study, at the time the study began, if given*	Control trial of herbicide application against control plots. Each plot was 5x5m. **All measures are in lbs/acre a.i.** Experiment undertaken in the Dee Estuary, Wirral, U.K.
2.2	What are the main characteristics of the population? *Include all relevant characteristics – e.g. age, sex, health status, location*	*S. townsendii*
2.3	If the treatment and control groups are **not** similar at the start of the trial give details of difference here	N/A
2.4	What intervention (treatment, procedure) is being investigated in this study? List all interventions covered by the study.	Herbicide: Dalapon – "Dowpon" powder dissolved in water +0.1% "Agral" wetter Paraquat – Aqueous conc. With added "Agral" Fenuron – "Dybar" pellets (25% a.i.) Bromacil – "Hyvar-X" powder Amitrole-T – "Weedazol" aqueous conc.
2.5	What comparisons are made in the study?	Between treatments v control and between treatments
2.6	How long after intervention is the follow-up undertaken in the study?	5 months to 2 years after treatment
2.7	What outcome measure(s) are used in the study? *List all outcomes that are used to assess effectiveness of the interventions used.*	**Percentage kill** (where kill was complete or near following values used): 100% = no living shoots ±100% = 1-6 living shoots 99++% = <0.4% live *Spartina* cover of controls 99+% = <0.8% live *Spartina* cover of controls 99% = 1.0% live *Spartina* cover of controls **Living shoot height (cm)**
2.8	What size of effect is identified in the study? *List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.*	Percentage kill made in the two years following treatment in the Upper Marsh

				Follow-up time				
Herbicide	No. of doses	Total dose (lb/ac)	Months applied	Dec (1 month)	May (6 months)	Oct (11 months)	Dec (year 1)	June (year 2)
Dalapon	4	200	May, July, Sept, Nov	100	100	100	±100	99++
	3	150	July, Sept, Nov	80	100	100	±100	99+
	2	100	Sept, Nov	0	50	100	±100	98

	1	50	Nov	0	10	90	90	92
Paraquat	4	8	May, July, Sept, Nov	100	99++	98	98	97
	3	6	July, Sept, Nov	100	100	±100	±100	99++
	2	4	Sept, Nov	0	30	40	35	40
	1	2	Nov	0	10	10	5	5
Fenuron	4	240	Mar, May, June, July	100	98	98	99	98
	3	180	May, June, July	99	99	±100	99+	99
	2	120	June, July	94	98	90	80	94
	1	60	July	80	98	80	85	60
	1	60	Sept	30	50	90	92	94
	1	60	Oct	0	0	0	0	0

Percentage kill made in the two years following treatment in the Lower Marsh

				Follow-up				
Herbicide	No. of doses	Total dose (lb/ac)	Months applied	Dec (1 month)	May (6 months)	Oct (11 months)	Dec (year 1)	June (year 2)
Paraquat	4	8	May, July, Sept, Nov	94	100		92	92
	3	6	July, Sept, Nov	94	100		97	94
	2	4	Sept, Nov	0	0		20	10
	1	2	Nov	0	0		30	20
Fenuron	4	240	Mar, May, June, July	98	99++		99	100
	3	180	May, June, July	100	±100		97	94
	2	120	June, July	100	±100		99+	100
	1	60	July	75	80		93	92
	1	60	Sept	20	50		92	90
	1	60	Oct	0	0		0	0

Mean live shoot height in the Upper Marsh

		May (6 months)			Sept (1 year)		
Herbicide	Total dose (lb/ac)	n	mean	se	n	mean	se
Dalapon	200	0			6		
	150	0			4		
	100	41	18.8	0.9	1		
	50	129	18.1	0.7	98	24.9	1.2
Paraquat	8	8	7.5	1.5	28	23.9	3.2
	6	0			4	23.8	8.0
	4	20	15.5	1.1	51	39.7	5.6
	2	43	16.2	1.0	121	42.6	2.1
Fenuron	240	3	12.5	4.2	0		
	180	4	12.5	2.5	0		
	120	35	13.2	1.0	135	27.8	1.3
	60	27	12.9	1.0	93	24.3	1.5
	60	4	12.5	2.5	4	12.5	4.7
	60	63	17.9	1.0	146	51.5	2.1
Control	0	39	19.2	1.5	120	49.8	2.3

Mean live shoot height in the Lower Marsh

		May (6 months)			Sept (1 year)		
Herbicide	Total dose (lb/ac)	n	mean	se	n	mean	se
Paraquat	8	4	12.5	1.8	31	18.6	2.4
	6	23	10.8	0.7	83	26.5	1.6
	4	33	14.8	1.2	76	38.1	2.3
	2	82	13.3	0.7	106	40.7	2.0
Fenuron	240	9	14.2	1.9	19	32.3	4.7
	180	6	15.0	0.9	36	18.9	2.0
	120	2	7.5	0.0	6	19.2	1.6
	60	45	12.4	1.2	112	36.7	2.0
	60	12	15.0	1.7	42	26.3	2.9
	60	94	15.1	0.7	135	39.5	2.0
Control	0	77	13.6	1.0	119	48.0	2.0

Percentage kill with 1964 treatment

			Follow-up		
Herbicide	Dose (lb/ac	Month treat	6 months	1 year	2 years
Dalapon	50	June	100	99+	94
	50	July	25	99	88

			50	August	10	100	94
			100	June	99	99+	99
			100	July	85	100	99
			100	August	20	100	98
			25+25	June + July	99	100	99++
			50+50	June + July	99+	100	100
		Paraquat	4	June	75	88	75
			2	June	88	85	30
			2	July	30	30	0
			2	August	72	80	25
			2	August	35	50	10
			1.5	July	20	20	0
			1	July	20	10	0
			0.75	July	0	10	0
			0.5	July	8	10	0
			2+2	June + July	75	80	20
			1+1	June + July	50	30	0
			0.75+0.75	June + July	60	60	55
			0.5+0.5	June + July	20	0	0
		Fenuron	30	June	94	94	75
			60	June	90	88	75
			60	July	96	90	88
			60	August	100	100	96
			120	June	100	100	100
			120	July	100	100	94

Percentage kill

Bromacil	Amitrole-T	Date Treat	Days before inundation	% kill
20	0	16th August (10 months)	5	100
5	0			99++
5	4			100
0	4			30
0	4	31st August (11 months)	3.5	70
0	8			90
10	0			60
15	0			75

2.9	How was this study funded?	Hoylake Urban District Council Grant (Now Wirral Metropolitan Council, U.K.)
2.10	Does this study help to answer your key question? *Summarise the main conclusions of the study and indicate how it relates to the key question.*	Dalapon consistently gave the highest kills followed by the least regeneration, even at lower doses. High percentage kills were obtained with fenuron but these were followed by varying and sometimes comparatively large amounts of regrowth.

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Taylor, M.C., Burrows, E.M., 1968. Chemical control of fertile Spartina townsendii (S.L.) on the Cheshire shore of the Dee Estuary: 2. Response of Spartina to treatment with Paraquat. Weed Research 8, 185-195.

Intervention: **Herbicide (Paraquat)**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

In a well conducted study…..		***In this study this criterion is:***	
1.1	The study addresses an appropriate and clearly focused question.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable

1.3	If randomised was an adequate concealment method used	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable
1.4	The treatment and control groups are similar at the start of the trial	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable
1.5	The only difference between groups is the treatment under investigation.	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable
1.6	All relevant outcomes are measured in a standard, valid and reliable way	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable
1.7	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Well covered Adequately addressed Poorly addressed Not addressed Not reported Not applicable

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study? *Also indicate number in each arm of the study, at the time the study began, if given*	Various glasshouse experiments of treatment on different age/vegetative states of *S. townsendii*.
2.2	What are the main characteristics of the population? *Include all relevant characteristics – e.g. age, sex, health status, location*	*Spartina townsendii*
2.3	If the treatment and control groups are **not** similar at the start of the trial give details of difference here	N/A
2.4	What intervention (treatment, procedure) is being investigated in this study? List all interventions covered by the study.	Herbicide: Paraquat applied at 2lb/acre
2.5	What comparisons are made in the study?	Between treatments
2.6	How long after intervention is the follow-up undertaken in the study?	Dependant on experiment – 2 weeks to 6 months
2.7	What outcome measure(s) are used in the study? *List all outcomes that are used to assess effectiveness of the interventions used.*	No. of leaves per main stem No. of shoots per seedling Percent plants killed
2.8	What size of effect is identified in the study? *List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.*	The effects of paraquat (2lbs/ac) on Spartina seedlings

			Percent plants killed (weeks after treatment)			
Age (weeks)	No. of leaves per main stem	No. of shoots per seedling	2	4	6	8
6	1.5±0.0	1.0±0.0	100	100	100	100
12	4.3±0.1	1.1±0.1	98	100	100	100
18	7.7±0.1	2.3±0.2	88	88	98	98
24	9.9±0.1	4.8±0.3	28	48	Missing	

The percentage of plants killed by paraquat (2lbs/ac)

	Weeks after treatment				
Stage of plant	4	8	12	16	20
Seedling with one shoot	80	100	100	100	100
Seedling with three shoots	53	100	100	100	100
Small vegetative plants	0	27	47	47	47
Small flowering plants	0	7	13	20	20

The percentage increase in shoot number on treated & control plants after 20 weeks.

Stage of plant	Control	Treated	Control/Treated
Seedling with one shoot	300	0.0	0.0
Seedling with three	120	0.0	0.0

		shoots			
		Small vegetative plants	116.9	23.4	0.2
		Small flowering plants	67	41.6	0.6
2.9	How was this study funded?	Hoylake Urban District Council Grant (Now Wirral Metropolitan Council, U.K.)			
2.10	Does this study help to answer your key question? *Summarise the main conclusions of the study and indicate how it relates to the key question.*	The results show that changes occur during the development of *Spartina* which render it less susceptible to paraquat with age.			

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Thom, R., Cordell, J.R., Simenstad, C.A., Luiting, V., Borde, A.B., 1997. Autecology of Spartina in Willapa Bay, Washington: Benethic Metabolism and Below Ground Growth, Second International Spartina Conference, Olympia, WA, U.S.A., pp. 18-20.

Intervention: **Cutting (clipping) & Burying**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

In a well conducted study…..		***In this study this criterion is:***	
1.1	The study addresses an appropriate and clearly focused question.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.3	If randomised was an adequate concealment method used	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.4	The treatment and control groups are similar at the start of the trial	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.5	The only difference between groups is the treatment under investigation.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.6	All relevant outcomes are measured in a standard, valid and reliable way	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.7	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study? *Also indicate number in each arm of the study, at the*	Lab based Control Trial undertaken with Spartina from Washington Harbour, USA.

	time the study began, if given	
2.2	What are the main characteristics of the population? *Include all relevant characteristics – e.g. age, sex, health status, location*	*S. alterniflora*
2.3	If the treatment and control groups are **not** similar at the start of the trial give details of difference here	N/A
2.4	What intervention (treatment, procedure) is being investigated in this study? *List all interventions covered by the study.*	**Cutting (clipping) & Burying**
2.5	What comparisons are made in the study? *Are comparisons made between treatments, or between treatment and control / no treatment group?*	Between treatments and treatment & control
2.6	How long after intervention is the follow-up undertaken in the study?	9 months
2.7	What outcome measure(s) are used in the study? *List all outcomes that are used to assess effectiveness of the interventions used.*	Mean biomass (g dry wt)
2.8	What size of effect is identified in the study? *List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.*	Results of the Spartina clipping & burying

Treatment	n	Mean biomass after 9 months (g dry wt)	sd	Mean biomass 1 month after harvest (g dry wt)	sd
Control	3	21.90	10.05	0.76	0.72
Buried only	3	21.39	5.91	1.03	0.88
Cut, buried	3	8.91	10.94	0.47	0.81
Cut only	3	15.75	4.71	1.25	1.41

2.9	How was this study funded?	University of Washington Sea Grant
2.10	Does this study help to answer your key question? *Summarise the main conclusions of the study and indicate how it relates to the key question.*	Burial only was not different from untreated controls. Clipping and burial had the least regrowth. In two of the three replicates regrowth did not occur, with roots and rhizomes appearing dead.

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Turner, M.G., 1987. Effects of grazing by feral horses, clipping, trampling, and burning on a Georgia salt marsh. Estuaries 10, 54-60.

Intervention: **Herbivory (feral horses), Trampling Burning & Clipping & combinations of treatments**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

In a well conducted study…..		***In this study this criterion is:***	
1.1	The study addresses an appropriate and clearly focused question.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable

1.3	If randomised was an adequate concealment method used	Well covered / Adequately addressed / Poorly addressed / Not addressed / Not reported / Not applicable
1.4	The treatment and control groups are similar at the start of the trial	Well covered / **Adequately addressed** / Poorly addressed / Not addressed / Not reported / Not applicable
1.5	The only difference between groups is the treatment under investigation.	Well covered / **Adequately addressed** / Poorly addressed / Not addressed / Not reported / Not applicable
1.6	All relevant outcomes are measured in a standard, valid and reliable way	Well covered / **Adequately addressed** / Poorly addressed / Not addressed / Not reported / Not applicable
1.7	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Well covered / Adequately addressed / Poorly addressed / Not addressed / Not reported / **Not applicable**

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study? *Also indicate number in each arm of the study, at the time the study began, if given*	All treatments except grazing were contained within enclosures. Replicated = 2 (number of sites) approx. 600m apart. Clipping was done bi-monthly from July '83 to Nov'84 with weed trimmer, cutting to 10-15cm above substrate. Trampling was simulated bi-weekly using trowel. Burning took place once in March'84. Follow-up in July'84 Undertaken at Cumberland Island, Camden County, Gerogia, USA.
2.2	What are the main characteristics of the population? *Include all relevant characteristics – e.g. age, sex, health status, location*	*S. alterniflora*
2.3	If the treatment and control groups are **not** similar at the start of the trial give details of difference here	N/A
2.4	What intervention (treatment, procedure) is being investigated in this study? *List all interventions covered by the study.*	Herbivory (feral horses), Trampling Burning & Clipping & combinations of treatments
2.5	What comparisons are made in the study? *Are comparisons made between treatments, or between treatment and control / no treatment group?*	Between treatments and treatment and control
2.6	How long after intervention is the follow-up undertaken in the study?	Varied with treatment see below
2.7	What outcome measure(s) are used in the study? *List all outcomes that are used to assess effectiveness of the interventions used.*	Live biomass (g/m^2) Standing dead (g/m^2) Live rhizomes (g/m^2 to 10cm)
2.8	What size of effect is identified in the study? *List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.*	Mean aboveground *Spartina* and live rhizomes (July 1984)

Treatment	Follow-up	Live biomass (g/m^2)	Standing dead (g/m^2)	Live rhizomes (g/m^2 to 10cm)
Control	1 year	344	210	523
Grazing	1 month	266	120	315
Trampling	2 months	237	106	239
Burning	4 months	232	103	361
Clipping	2 months	210	47	280
Burn & Grazed	1 month	198	88	235
Burn & Trampling	2 months	195	100	240
Burn, Clip	2 months	158	72	247

		& Trampling				
		Clipped & Trampling	2 months	135	42	231
		Burn & Clip	2 months	216	96	425
2.9	How was this study funded?	National Park Service Cooperative Research Unit				
2.10	Does this study help to answer your key question? *Summarise the main conclusions of the study and indicate how it relates to the key question.*	Burning seemed to be qualitatively different from both clipping and trampling. Plots which were burned exhibited a more dense growth of smaller (thinner) stems compared to unburned plots. Horses had a strong impact on large portions of the saltmarsh; however, grazing pressure was not uniform.				

Methodology Checklist: Randomised Controlled Trials & other experimental methods

Study identification (*Include author, title, year of publication, journal title, pages*)

Wu, M.Y., Hacker, S., Ayres, D., Strong, D.R., 1999. Potential of Prokelisia spp. as biological control agents of English cordgrass, Spartina anglica. Biological Control 16, 267-273.

Intervention: **Herbivory (*Prokelisia* - planthopper)**

Checklist completed by: **PDR**

Section 1: INTERNAL VALIDITY OF THE STUDY

In a well conducted study…..		***In this study this criterion is:***	
1.1	The study addresses an appropriate and clearly focused question.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.2	The assignment of subjects to treatment groups is randomised	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.3	If randomised was an adequate concealment method used	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.4	The treatment and control groups are similar at the start of the trial	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.5	The only difference between groups is the treatment under investigation.	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.6	All relevant outcomes are measured in a standard, valid and reliable way	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable
1.7	Where the study is carried out at more than one site, can the results be compared for all sites under investigation?	Well covered Adequately addressed Poorly addressed	Not addressed Not reported Not applicable

Section 2: DESCRIPTION OF THE METHODS & OUTCOMES OF THE STUDY

(The following information is required to complete evidence tables facilitating cross-study comparisons. Please complete all sections for which information is available).

2.1	What is the experimental design used in this study? *Also indicate number in each arm of the study, at the*	Control Trial undertaken in lab conditions to assess the potential of two planthoppers as biological control

<table>
<tr><td></td><td>time the study began, if given</td><td>agents.</td></tr>
<tr><td>2.2</td><td>What are the main characteristics of the population?
Include all relevant characteristics – e.g. age, sex, health status, location</td><td>S. anglica

Herbivore: Prokelisia marginata & P. dolus</td></tr>
<tr><td>2.3</td><td>If the treatment and control groups are <u>not</u> similar at the start of the trial give details of difference here</td><td></td></tr>
<tr><td>2.4</td><td>What intervention (treatment, procedure) is being investigated in this study?
List all interventions covered by the study.</td><td>Herbivory (Prokelisia - planthopper)</td></tr>
<tr><td>2.5</td><td>What comparisons are made in the study?
Are comparisons made between treatments, or between treatment and control / no treatment group?</td><td>Between Treatments</td></tr>
<tr><td>2.6</td><td>How long after intervention is the follow-up undertaken in the study?</td><td>5 months & 10 months</td></tr>
<tr><td>2.7</td><td>What outcome measure(s) are used in the study?
List all outcomes that are used to assess effectiveness of the interventions used.</td><td>Percent mortality</td></tr>
<tr><td>2.8</td><td>What size of effect is identified in the study?
List all measures of effect in the units used in the study – e.g. densities, % change etc. Include p values and any confidence intervals that are provided.</td><td>Mortality of Spartina plants
<table>
<tr><th>Follow-up</th><th>Very low density of both P. marginata & P. dolus (used as control)</th><th>High Density P. marginata</th><th>High Density P. dolus</th></tr>
<tr><td>5 months</td><td><1</td><td>93</td><td>93</td></tr>
<tr><td>10 months</td><td><1</td><td>92</td><td>93</td></tr>
</table></td></tr>
<tr><td>2.9</td><td>How was this study funded?</td><td>California Sea Grant</td></tr>
<tr><td>2.10</td><td>Does this study help to answer your key question?
Summarise the main conclusions of the study and indicate how it relates to the key question.</td><td>The results of the study suggest that Prokelisia spp. Have the potential for the biological control of S. anglica. Within 4 months more than 90% of plants were killed in the high-density planthopper treatments. This mortality was in contrast to the low mortality of control plants with very low densities of planthoppers.</td></tr>
</table>