Spartina densiflora in SW Iberian Peninsula: Ongoing Ecological Research and Applications for Salt Marsh Restoration

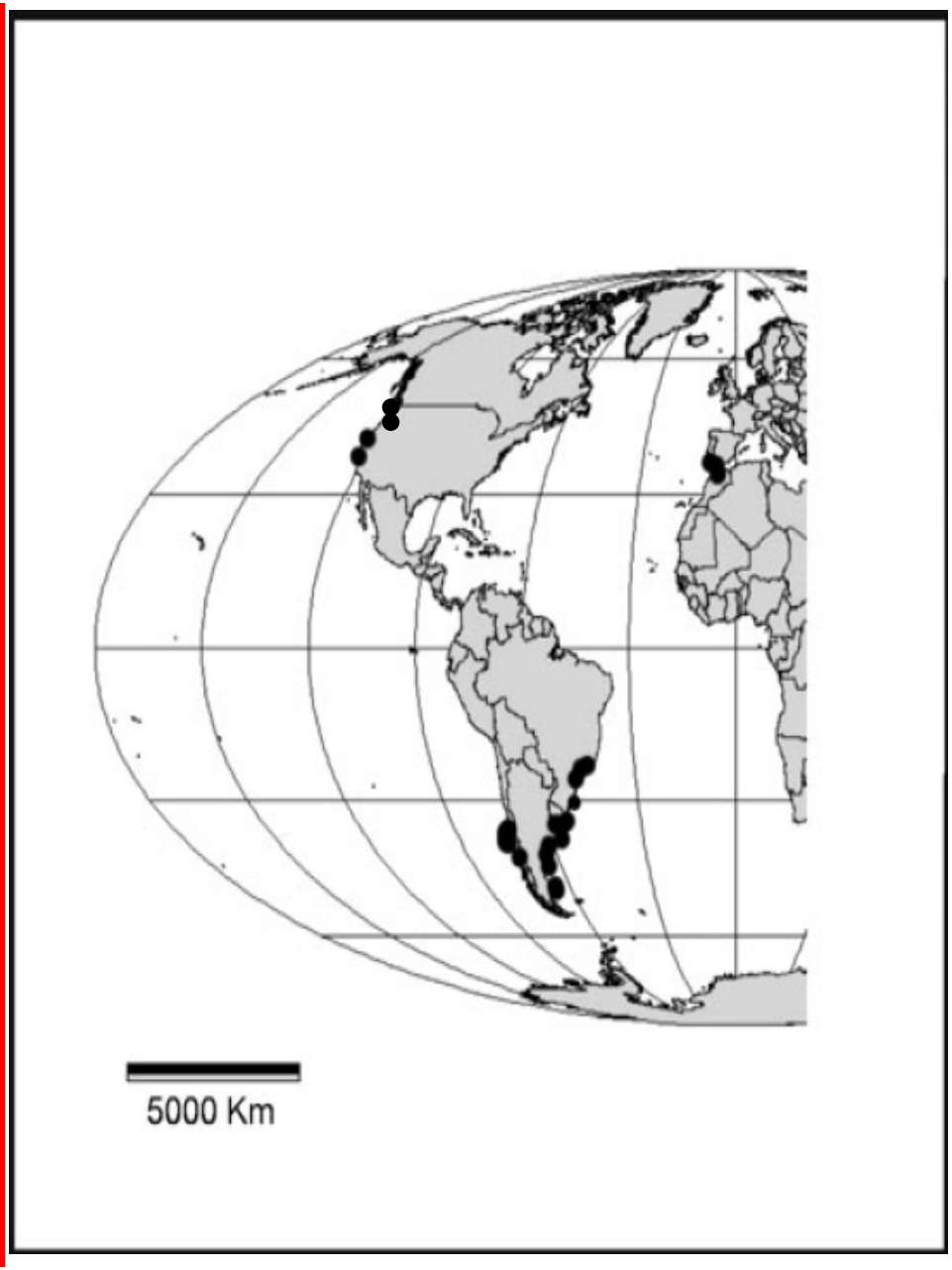
Humboldt Bay – June 2010

UNIVERSIDAD DE SEVILLA

GEC NAT

GRUPO DE ECOLOGÍA CITOGENÉTICA Y RECURSOS NATURALES

'Conrades on *Spartina densiflora*'



CONGRATULATIONS!

YOU ALL ARE DOING
A GREAT JOB FIGHTING
SPARTINA INVASIONS!!!

(However in some places we have a long way to walk…)

(… and in other places we need to start walking…)

Molecular Ecology (2008) 17, 4304–4316 doi: 10.1111/j.1365-294X.2008.03916.x

The enigmatic invasive *Spartina densiflora*: A history of hybridizations in a polyploidy context

P. M. FORTUNE,*,** K. SCHIERENBECK,† D. AYRES,‡ A. BORTOLUS,§ O. CATRICE,¶ S. BROWN¶ and M. L. AINOUCHE*

American Journal of Botany 95(6): 1–7. 2008.

Hybridization between invasive *Spartina densiflora* (Poaceae) and native *S. foliosa* in San Francisco Bay, California, USA[1]

Debra R. Ayres,[2,7] Eva Grotkopp,[2] Katherine Zaremba,[3] Christina M. Sloop,[2] Michael J. Blum,[4] John P. Bailey,[5] Carina K. Anttila,[6] and Donald R. Strong[2]

S. densiflora x foliosa in SF Bay, CA, USA

Diversity and Distributions, (*Diversity Distrib.*) (2010) 1–12

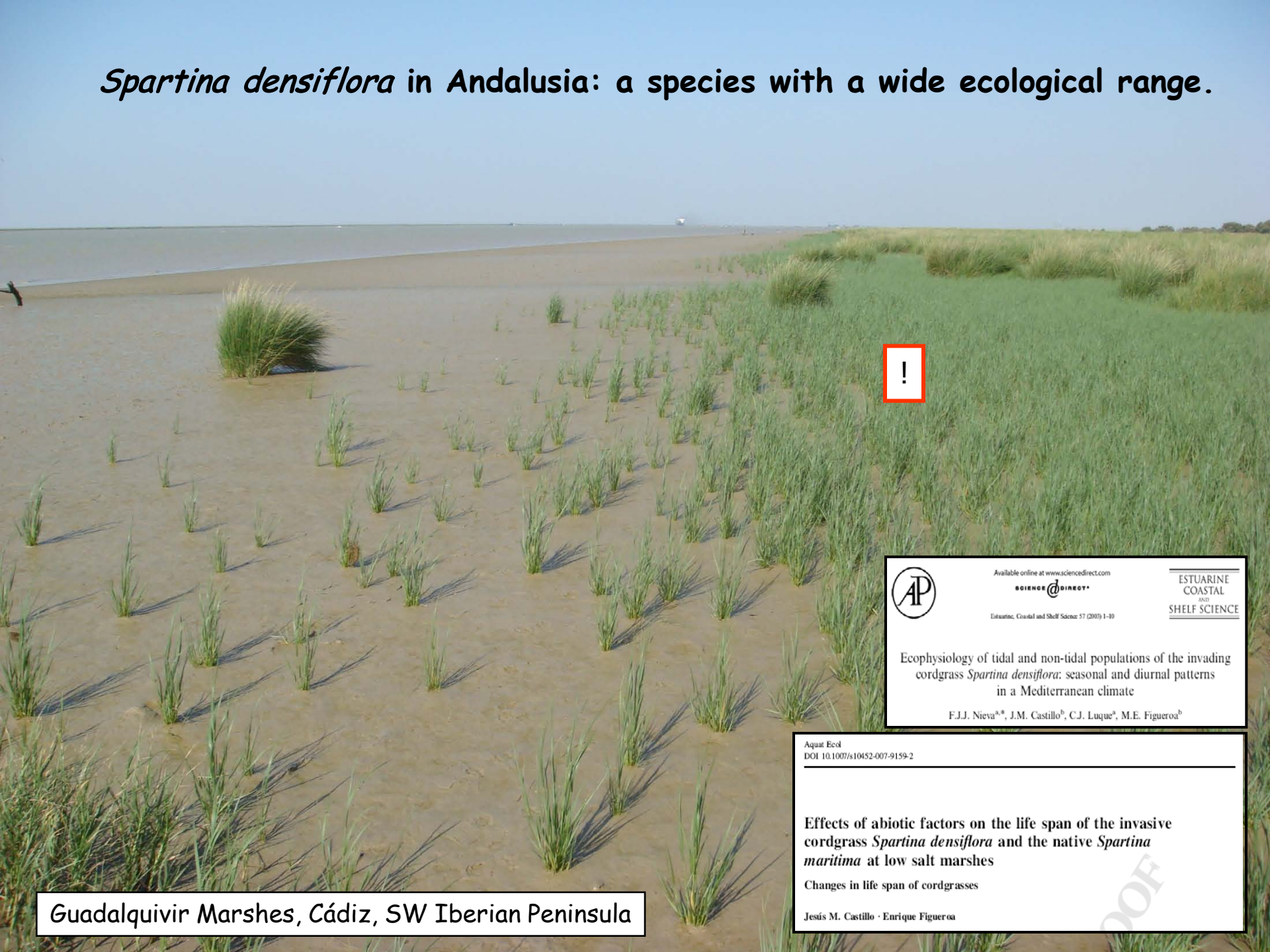
BIODIVERSITY RESEARCH

The production of hybrids with high ecological amplitude between exotic *Spartina densiflora* and native *S. maritima* in the Iberian Peninsula

J.M. Castillo[1]*, D.R. Ayres[2], P. Leira-Doce[1], J. Bailey[3], M. Blum[4], D.R. Strong[2], T. Luque[1] and E. Figueroa[1]

S. densiflora x maritima in SW Iberian Peninsula

Spartina densiflora in Andalusia: a species with a wide ecological range.



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Available online at www.sciencedirect.com
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Estuarine, Coastal and Shelf Science 57 (2003) 1–10
ESTUARINE COASTAL AND SHELF SCIENCE

Ecophysiology of tidal and non-tidal populations of the invading cordgrass *Spartina densiflora*: seasonal and diurnal patterns in a Mediterranean climate

F.J.J. Nieva[a,*], J.M. Castillo[b], C.J. Luque[a], M.E. Figueroa[b]

Aquat Ecol
DOI 10.1007/s10452-007-9159-2

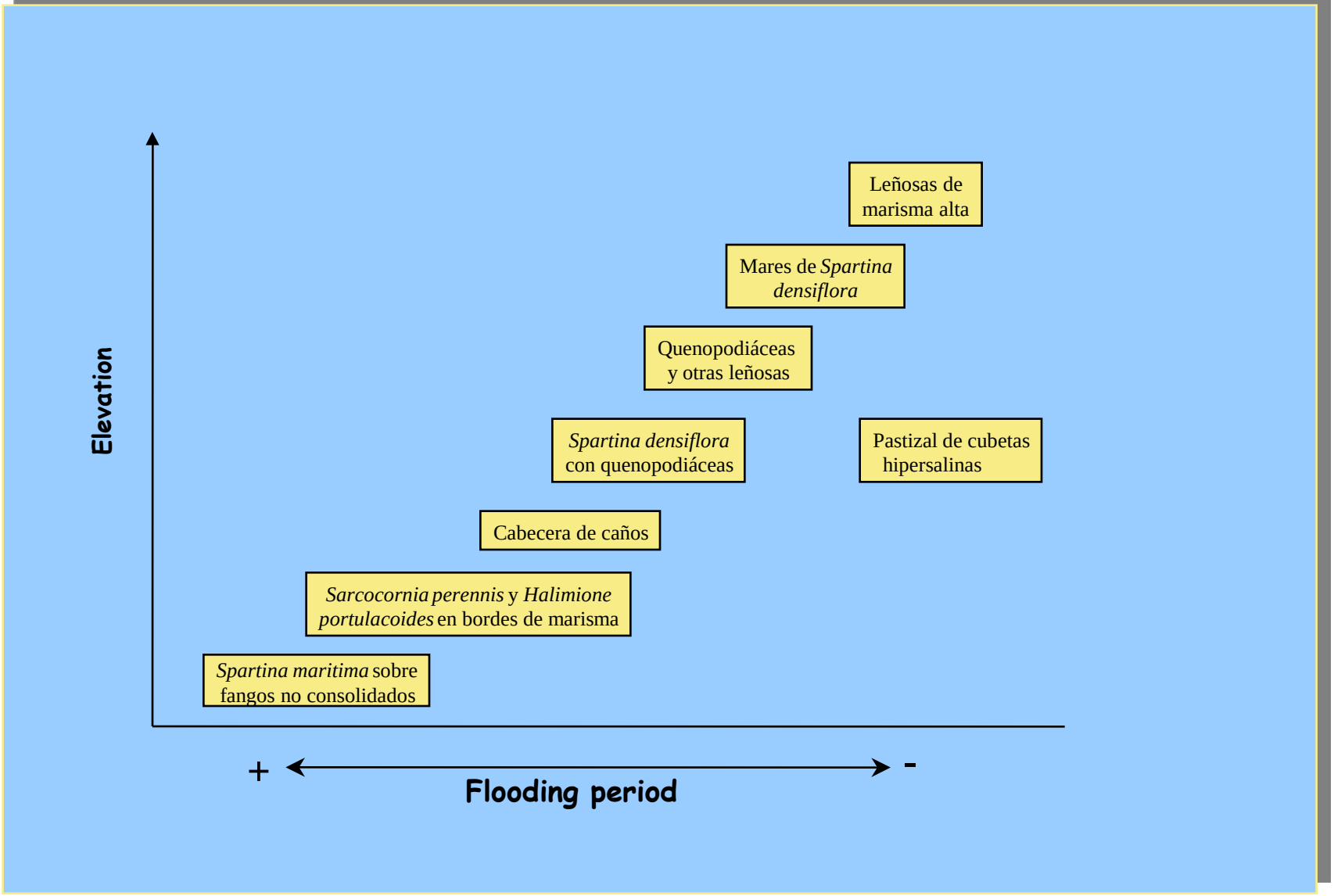
Effects of abiotic factors on the life span of the invasive cordgrass *Spartina densiflora* and the native *Spartina maritima* at low salt marshes

Changes in life span of cordgrasses

Jesús M. Castillo · Enrique Figueroa

Guadalquivir Marshes, Cádiz, SW Iberian Peninsula

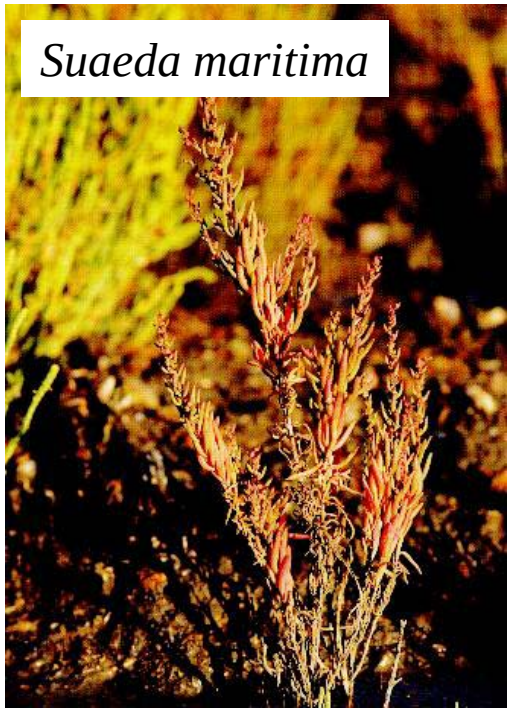
Plant communities invaded by *Spartina densiflora* in SW Iberian Peninsula.



The most affected plants by *Spartina densiflora* invasion in Andalusia are rare middle marsh species.

Middle marsh in Piedras Marshes, Huelva, SW Iberian Peninsula

Inula crithmoides


Suaeda maritima

Triglochin barrelieri

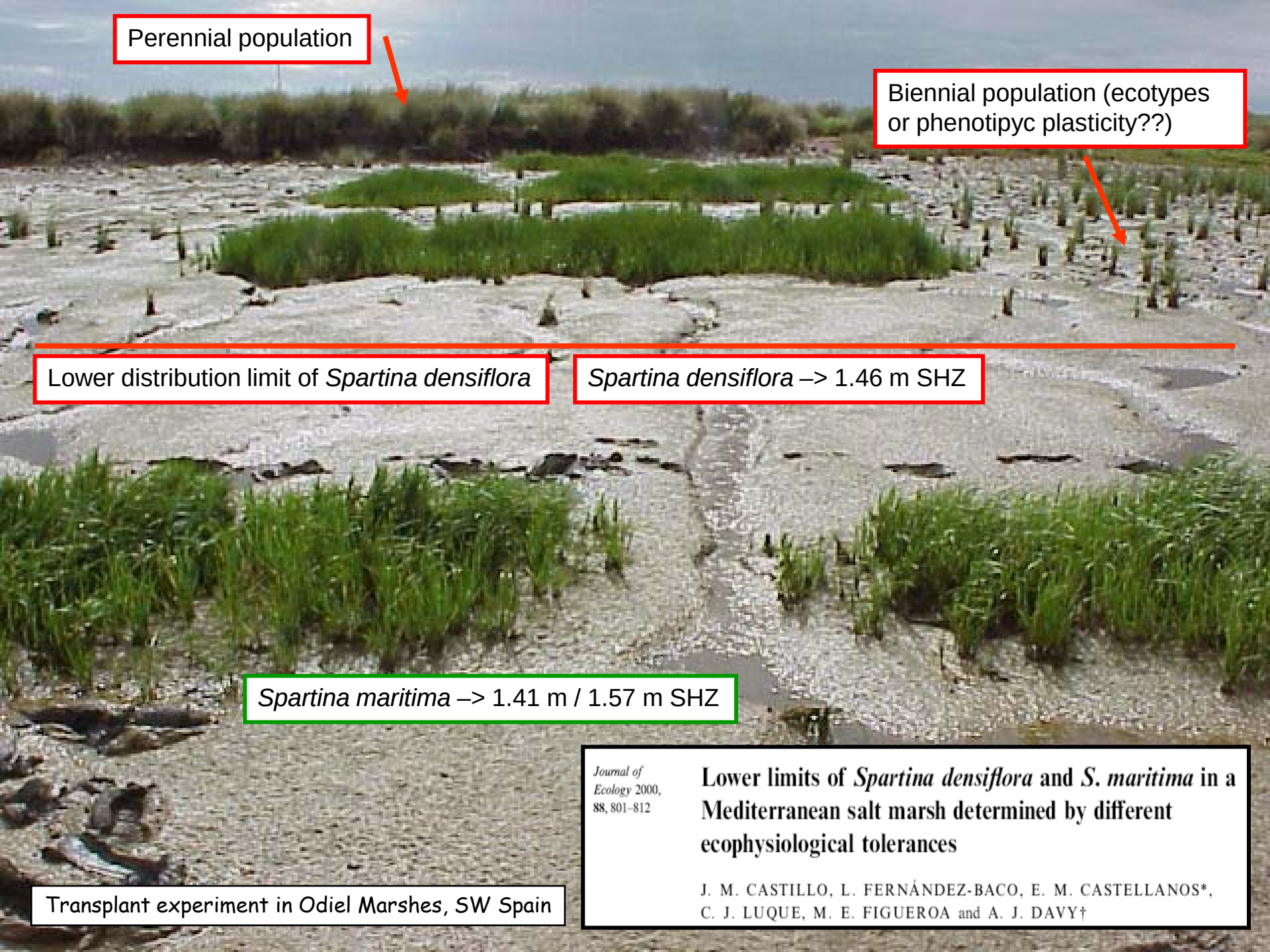
Artemisia chritmfolia
Aster tripolium

Frankenia sp.

Puccinelia sp.
© Ralph Forbes

Limonium sp.

Middle marsh in Humboldt Bay, California, USA



Journal of Ecology 2000, 88, 801–812

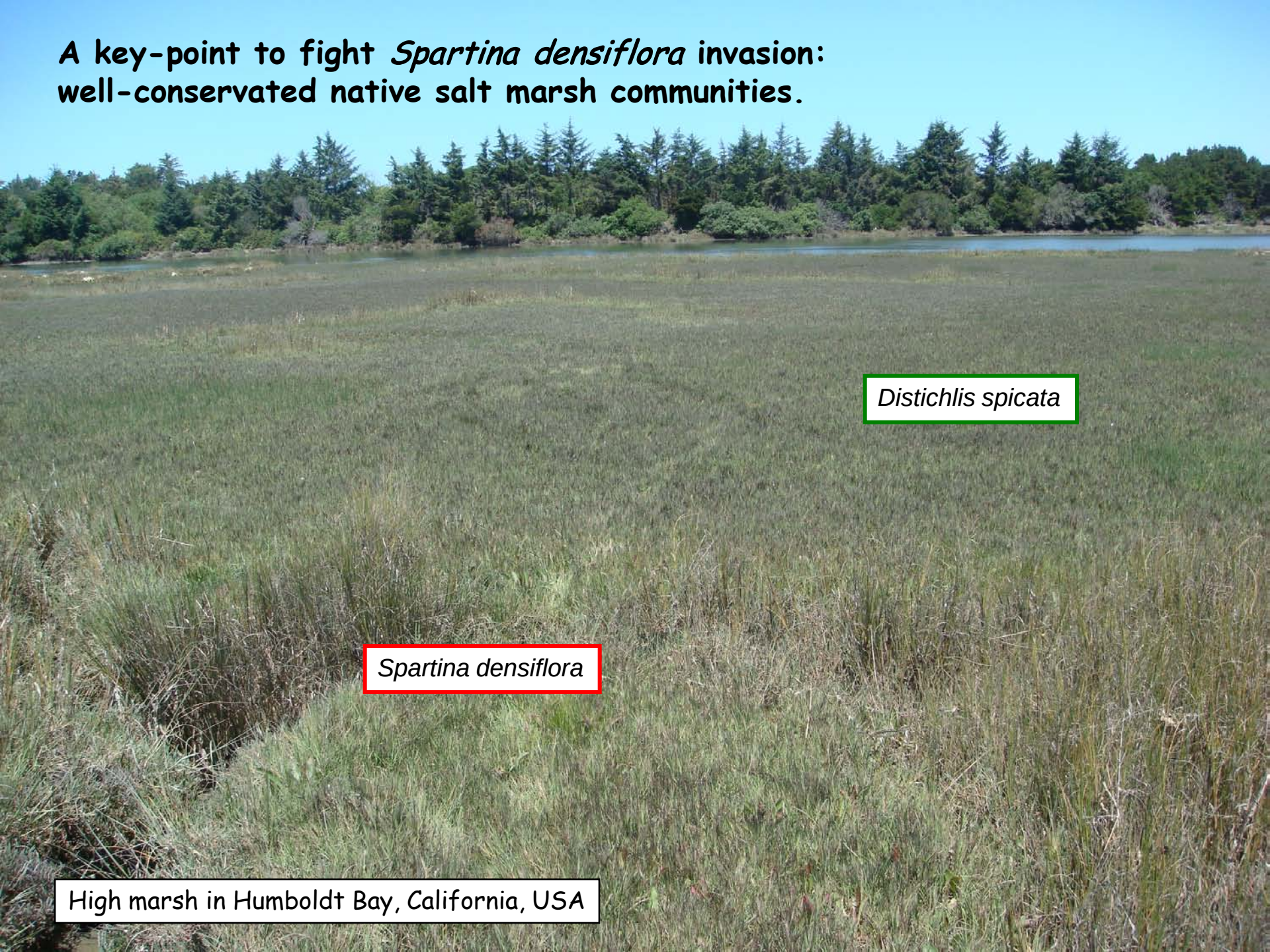
Lower limits of *Spartina densiflora* and *S. maritima* in a Mediterranean salt marsh determined by different ecophysiological tolerances

J. M. CASTILLO, L. FERNÁNDEZ-BACO, E. M. CASTELLANOS*, C. J. LUQUE, M. E. FIGUEROA and A. J. DAVY†

Spartina densiflora along North America West Coast: a narrower ecological range than in the Iberian Peninsula?

Ocean Shores, Grays Harbor, Washington, USA

A key-point to fight *Spartina densiflora* invasion: well-conservated native salt marsh communities.



High marsh in Humboldt Bay, California, USA

Hydrobiologia (2008) 614:363–371
DOI 10.1007/s10750-008-9520-z

PRIMARY RESEARCH PAPER

Plant zonation at salt marshes of the endangered cordgrass *Spartina maritima* invaded by *Spartina densiflora*

Jesús M. Castillo · Enrique Mateos-Naranjo ·
Francisco J. Nieva · Enrique Figueroa

Spartina maritima in Odiel Marshes, SW Iberian Peninsula

Experiment of competition between *Spartina densiflora* and *S. maritima* in Odiel Marshes, SW Iberian Peninsula

Salt marshes and Global Warming

Journal of Experimental Botany, Vol. 61, No. 6, pp. 1643–1654, 2010
doi:10.1093/jxb/erq029 Advance Access publication 1 March, 2010
This paper is available online free of all access charges (see http://jxb.oxfordjournals.org/open_access.html for further details)

Journal of Experimental Botany
www.jxb.oxfordjournals.org

RESEARCH PAPER

Synergic effect of salinity and CO_2 enrichment on growth and photosynthetic responses of the invasive cordgrass *Spartina densiflora*

Enrique Mateos-Naranjo*, Susana Redondo-Gómez, Rosario Álvarez, Jesús Cambrollé, Jacinto Gandullo and M. Enrique Figueroa

	R	E	C	0	4	6	5	B	Dispatch: 24.8.08	Journal: REC	CE: Shamini
Journal Name				Manuscript No.					Author Received:	No. of pages: 3	ME: Senthil Jr.

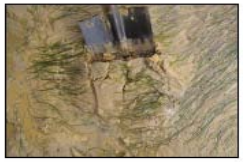
Restoring Salt Marshes Using Small Cordgrass, *Spartina maritima*

Jesús M. Castillo[1,2] and Enrique Figueroa[2]

Figure 1. Main physiographical locations of the restored marshes before (left) and after (right) *Spartina maritima* plantings: slightly sloping channel bank (above) and flat interior marsh (below).

Figure 2. *Sarcocornia perennis* subspecies *perennis* growing next to *Spartina maritima* clumps at an interior restored marsh.

Se plantaron alrededor 120.000 m² con *Spartina maritima* y varias parcelas piloto de *Zostera noltii*, debido a la ausencia de experiencias previas de trasplantes con esta última especie en el Golfo de Cádiz. El seguimiento de estas parcelas piloto demostró que la metodología empleada era idónea para la propagación de esta especie amenazada en la creación de nuevos enclaves.



Transplantes de *Zostera noltii*

Zostera noltii transplant

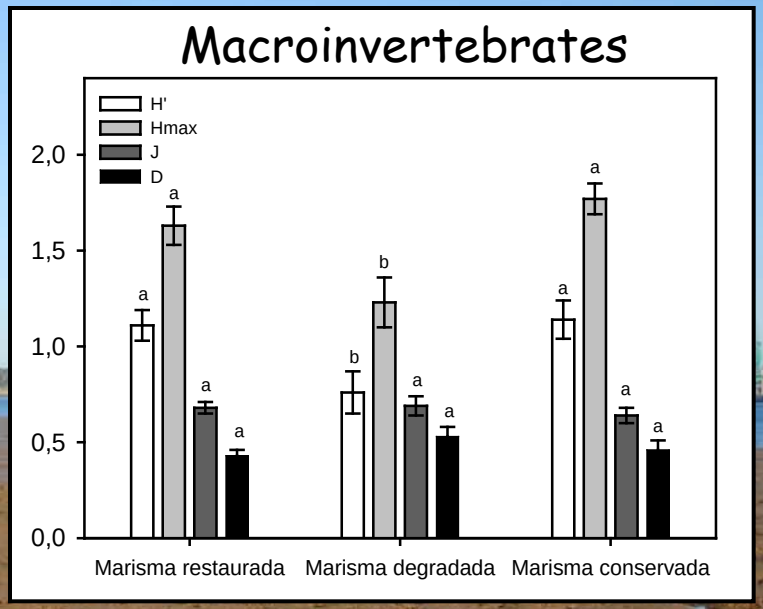
Removing *Spartina densiflora*

Spartina maritima as a biotool

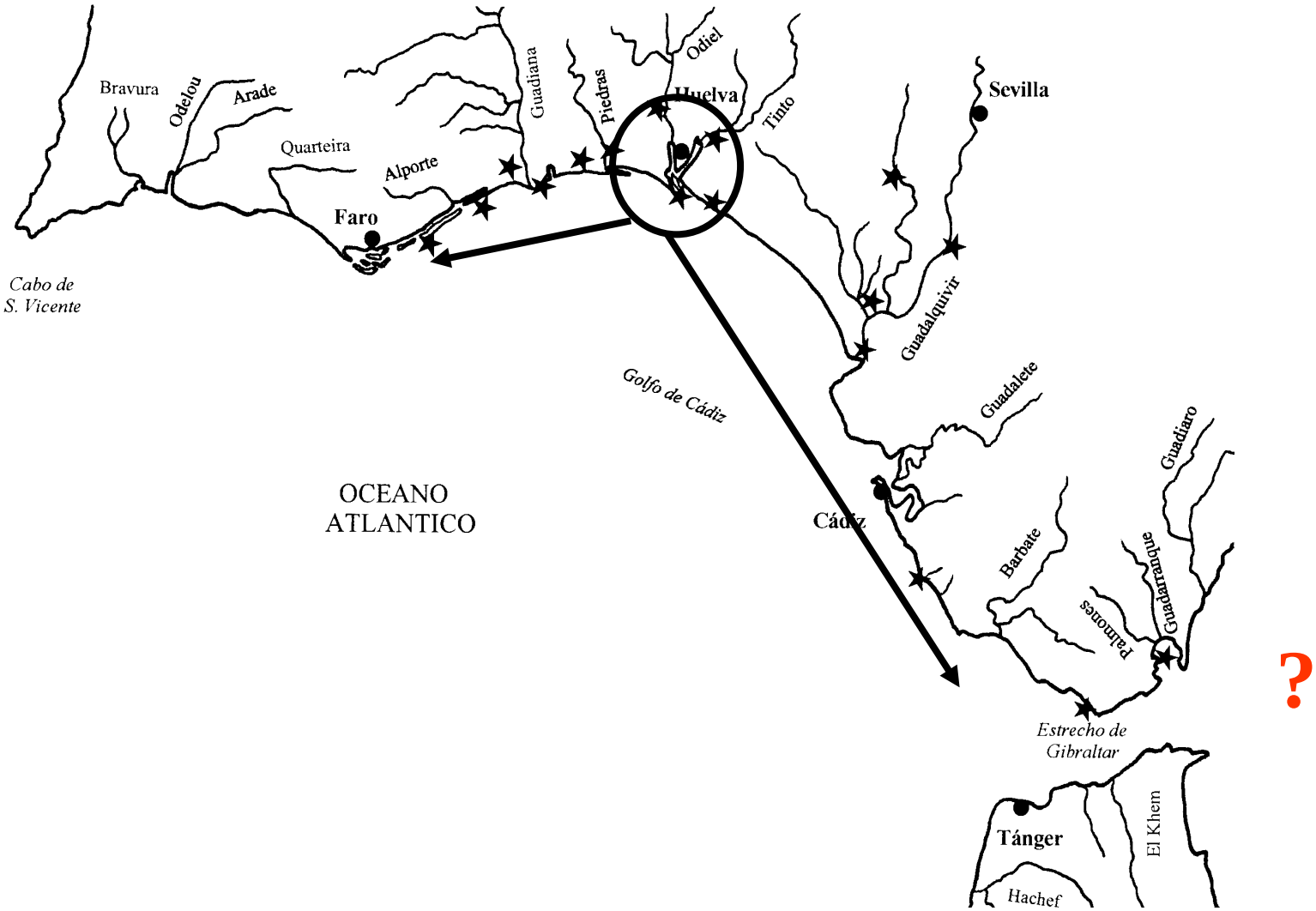
Marisma baja antes y después de la plantación

Microhabitats diversification after *S. densiflora* removal (terrestrialization)

Impacts of *S. densiflora* invasion on animal communities



Regional/national erradication



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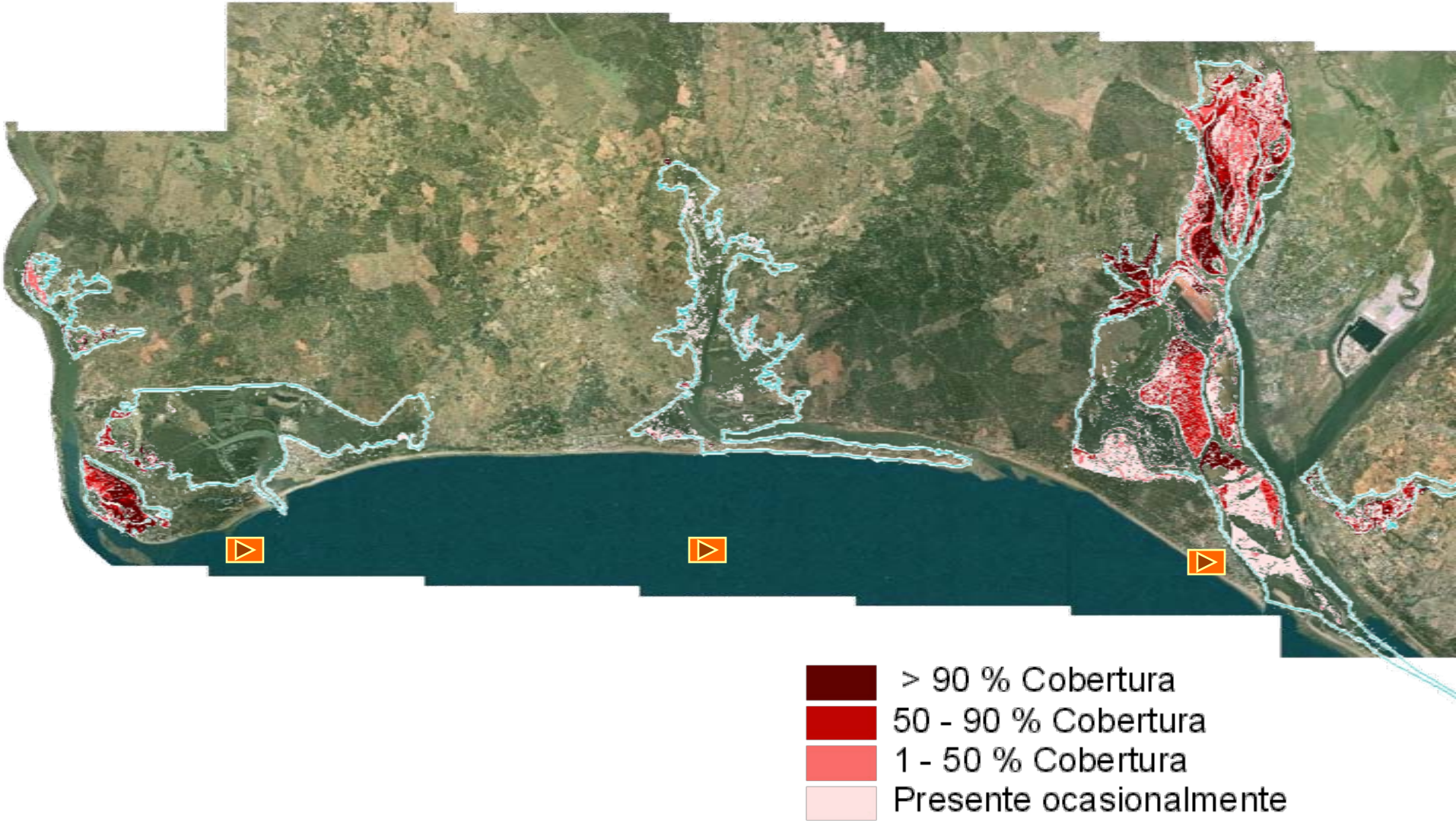
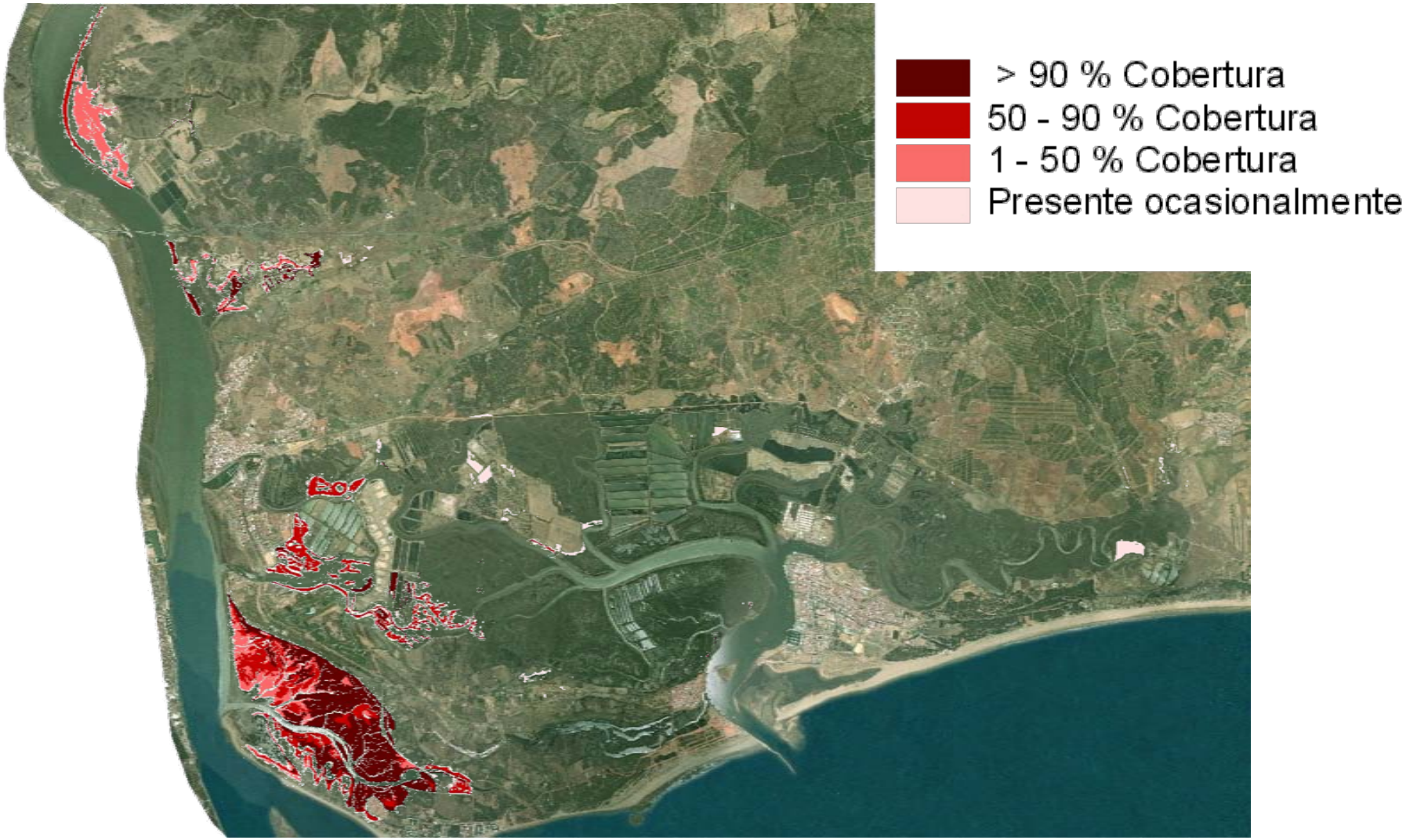
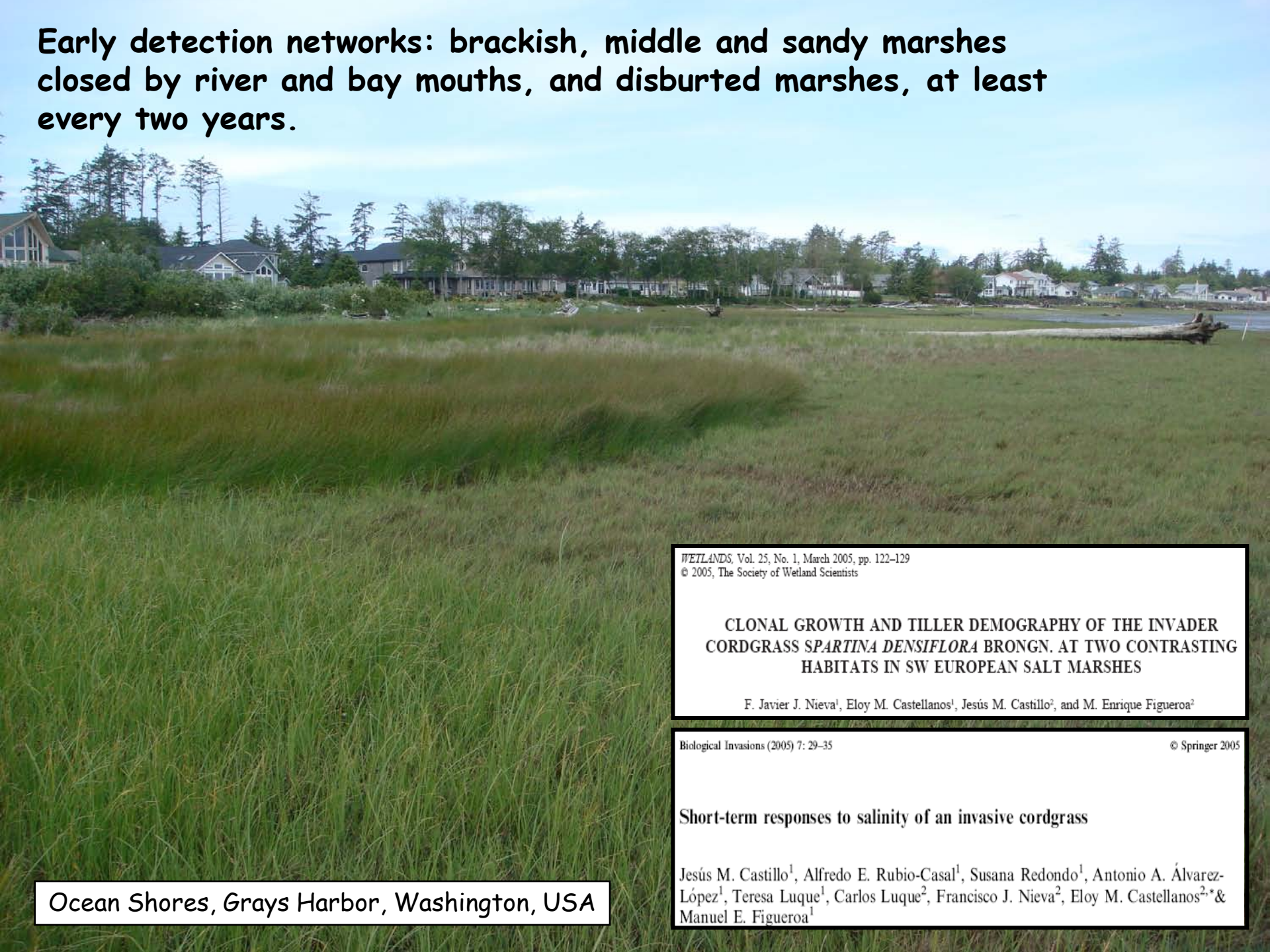
Spartina densiflora along West Huelva Coast



Spartina densiflora in Guadiana estuary



Early detection networks: brackish, middle and sandy marshes closed by river and bay mouths, and disburted marshes, at least every two years.



WETLANDS, Vol. 25, No. 1, March 2005, pp. 122–129
© 2005, The Society of Wetland Scientists

CLONAL GROWTH AND TILLER DEMOGRAPHY OF THE INVADER CORDGRASS *SPARTINA DENSIFLORA* BRONGN. AT TWO CONTRASTING HABITATS IN SW EUROPEAN SALT MARSHES

F. Javier J. Nieva[1], Eloy M. Castellanos[1], Jesús M. Castillo[2], and M. Enrique Figueroa[2]

Biological Invasions (2005) 7: 29–35 © Springer 2005

Short-term responses to salinity of an invasive cordgrass

Jesús M. Castillo[1], Alfredo E. Rubio-Casal[1], Susana Redondo[1], Antonio A. Álvarez-López[1], Teresa Luque[1], Carlos Luque[2], Francisco J. Nieva[2], Eloy M. Castellanos[2,*]& Manuel E. Figueroa[1]

Ocean Shores, Grays Harbor, Washington, USA

Spartina densiflora establishment.
Some very fresh results.

Seed bank?
Germination in darkness.
Spartina densiflora growing together with *Atriplex portulacoides* in a middle marsh in SW Iberian Peninsula

Contents lists available at ScienceDirect

Marine Pollution Bulletin

journal homepage: www.elsevier.com/locate/marpolbul

Germination and establishment of the invasive cordgrass *Spartina densiflora* in acidic and metal polluted sediments of the Tinto River

Guillermo Curado *, Alfredo E. Rubio-Casal *, Enrique Figueroa *, Jesús M. Castillo *

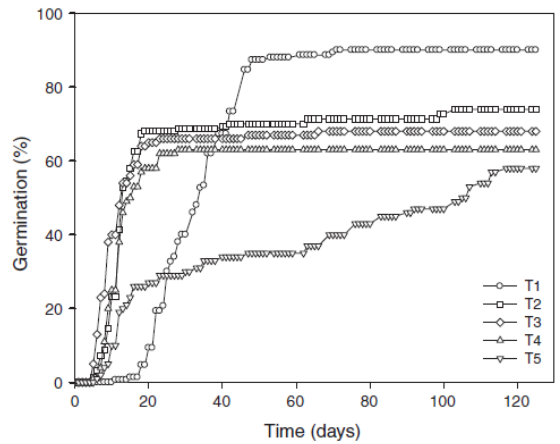


Fig. 2. Mean germination ($n = 4–6$) of seeds of *Spartina densiflora* during 127 days exposed to five treatments (T) composed of sediments collected along the Tinto River.

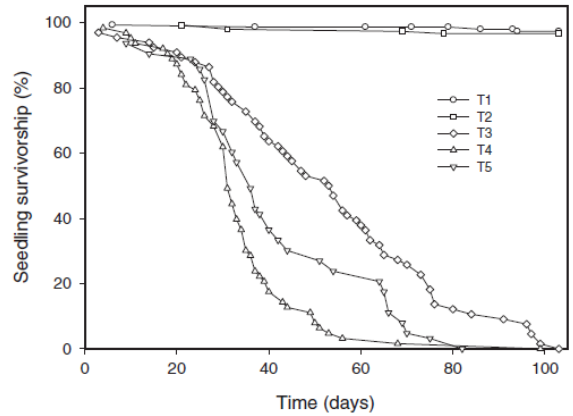


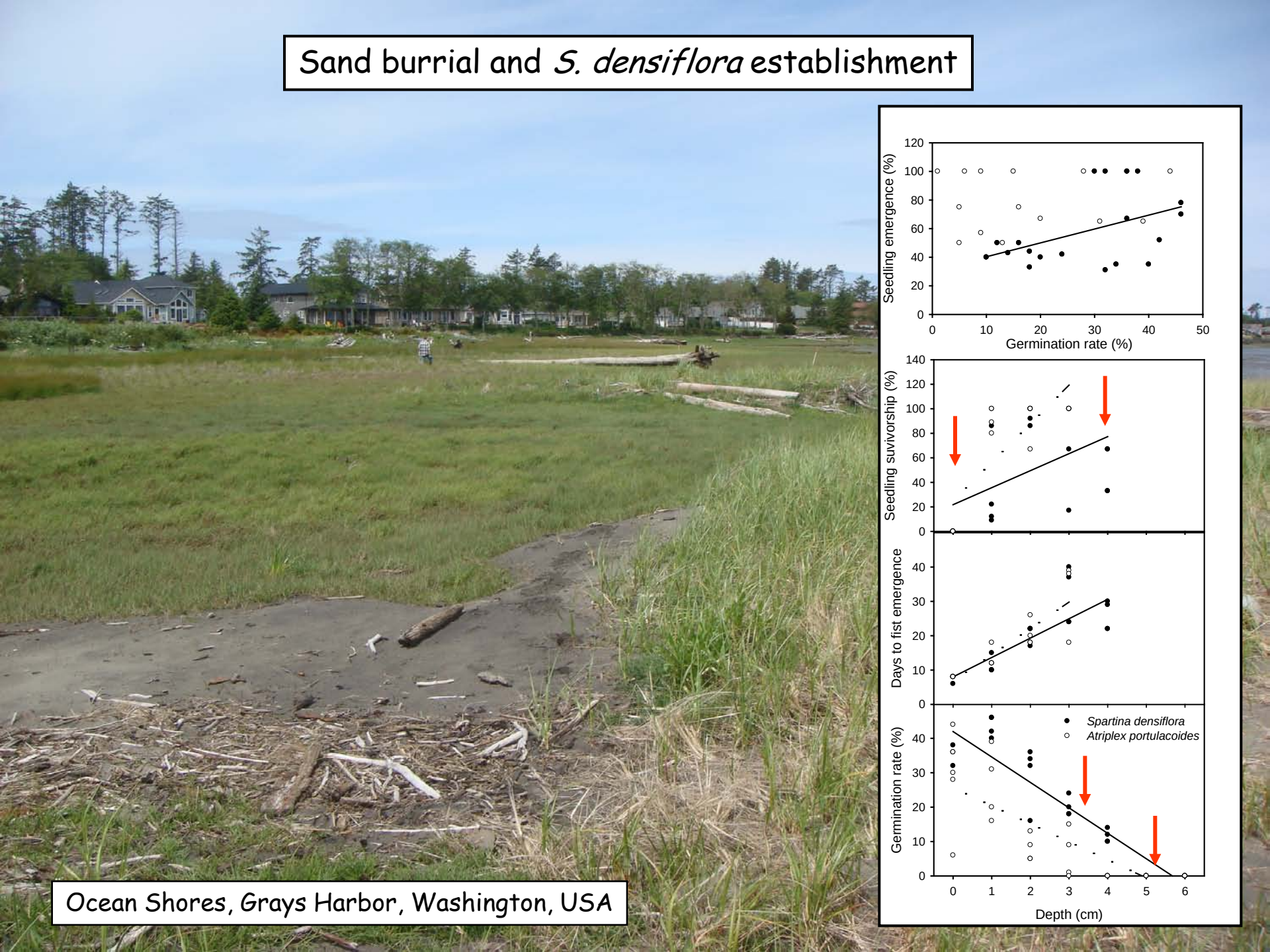
Fig. 3. Survivorship ($n = 4–6$) of *Spartina densiflora* seedlings over 112 days from the beginning of the experiment exposed to five treatments (T) composed of sediments collected along the Tinto River.

Treatment	Texture	Redox potential***	Conductivity***	pH***
1	98/1/1	171 ± 25^{a}	$6.8 \pm 0.5^{a,b}$	7.5 ± 0.0^{a}
2	89/7/4	258 ± 12^{b}	7.2 ± 0.3^{b}	4.0 ± 0.1^{b}
3	87/9/4	$510 \pm 15^{c,d}$	3.7 ± 0.3^{c}	2.9 ± 0.1^{c}
4	61/36/3	501 ± 6^{c}	5.1 ± 0.3^{c}	2.5 ± 0.1^{c}
5	25/69/6	475 ± 4^{d}	$5.3 \pm 0.3^{a,c}$	2.8 ± 0.1^{c}

Metals in Halophytes of a Contaminated Estuary (Odiel Saltmarshes, SW Spain)

CARLOS J. LUQUE*,‡, ELOY M. CASTELLANOS*, JESUS M. CASTILLO*, MANUEL GONZALEZ†, M. CARMEN GONZALEZ-VILCHES† and M. ENRIQUE FIGUEROA*

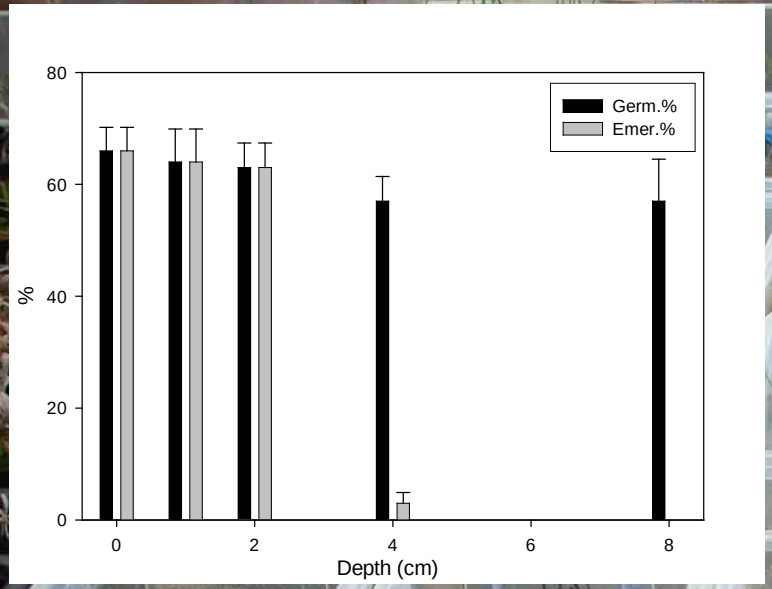
Sand burrial and *S. densiflora* establishment



Ocean Shores, Grays Harbor, Washington, USA

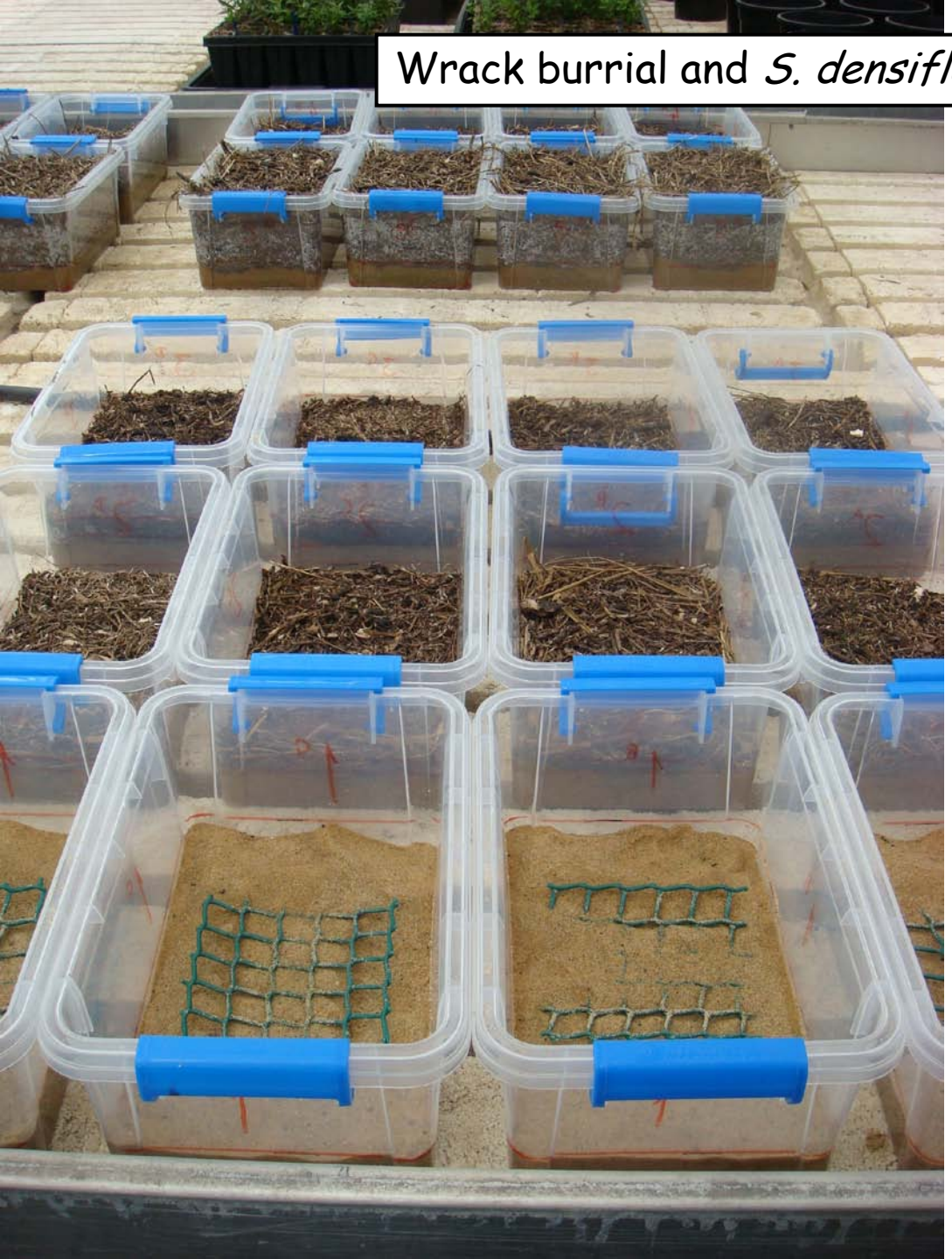
Permanent flooding and *S. densiflora* establishment
Sánchez Marsh, San Francisco Bay, CA, USA

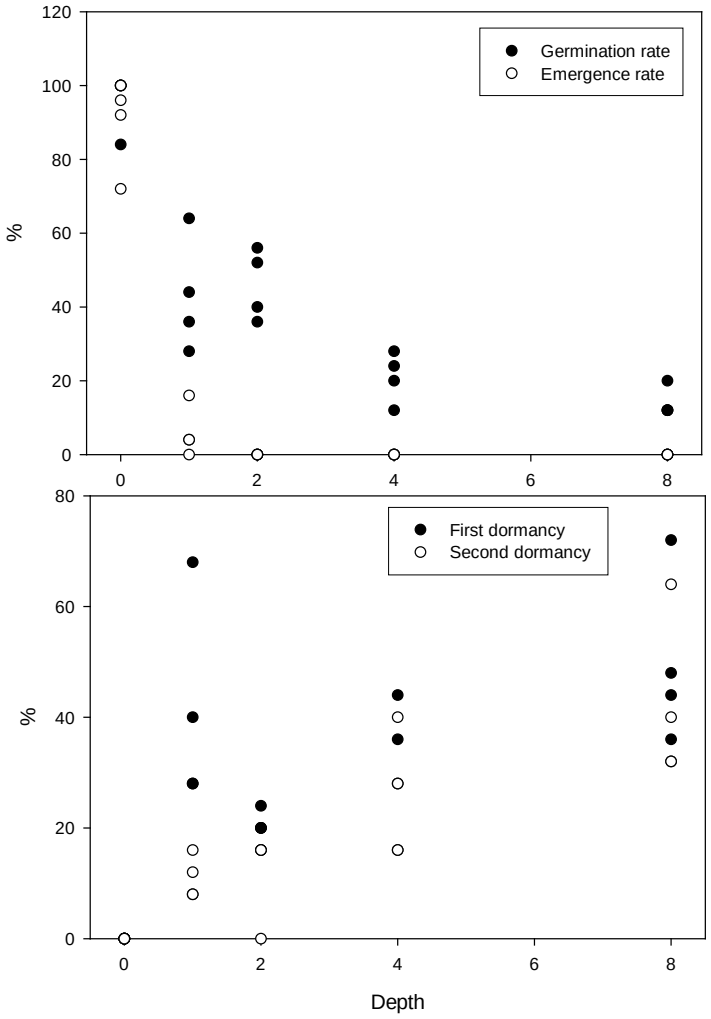
Permanent flooding and *S. densiflora* establishment



Wrack burrial and *S. densiflora* establishment
Humboldt Bay, CA, USA

Wrack burrial and *S. densiflora* establishment





Allelopathic effects???

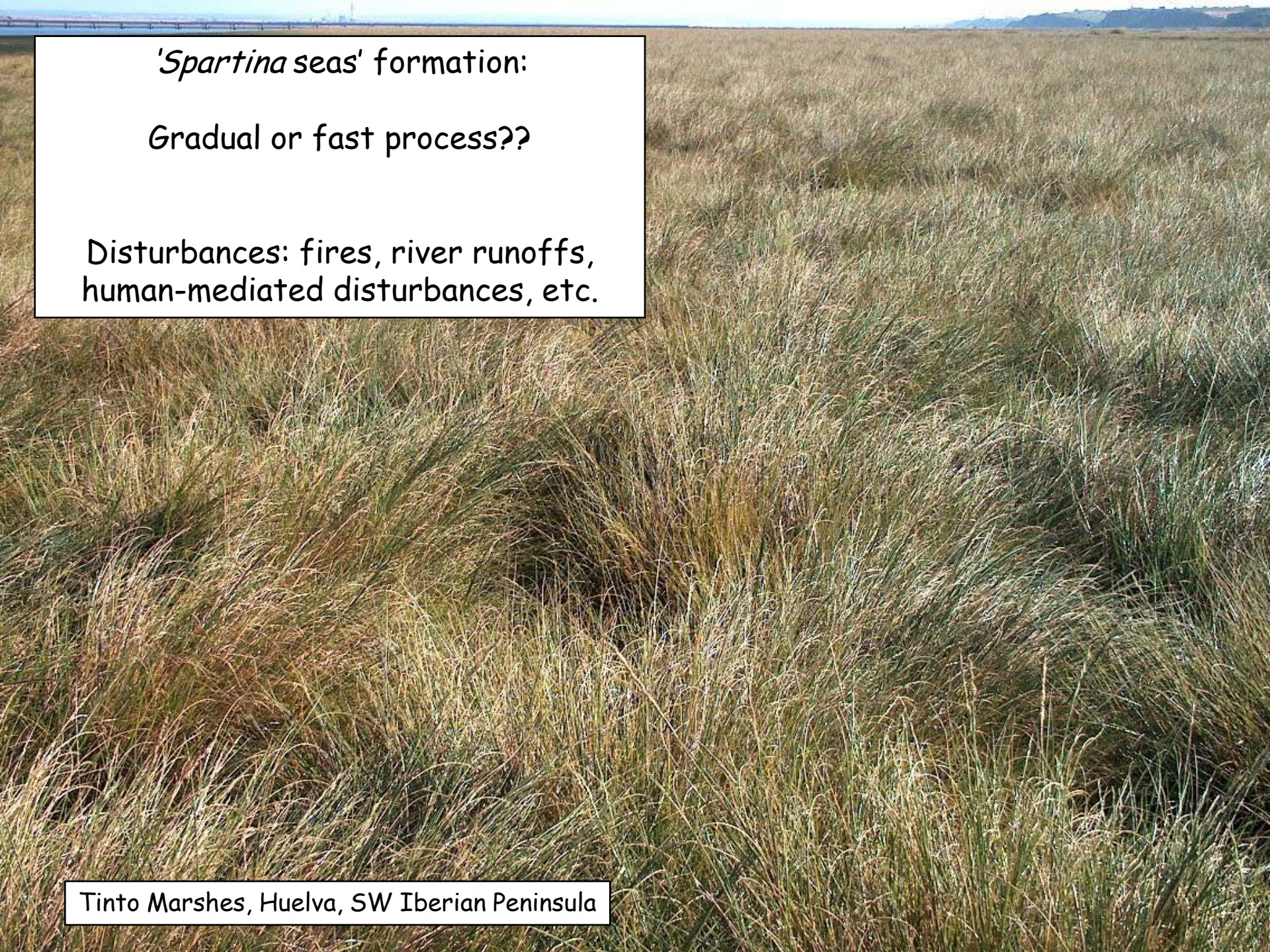
Glicophytes and *S. densiflora* establishment
Humboldt Bay, CA, USA

Experiment of competition between *Spartina densiflora* and the glycophytes *Phragmites australis* and *Typha dominguensis*.

How do '*Spartina densiflora* seas' develop??

How can we erradicate them???

Guadiana Marshes, Huelva, SW Iberian Peninsula



'*Spartina* seas' formation:

Gradual or fast process??

Disturbances: fires, river runoffs, human-mediated disturbances, etc.

Tinto Marshes, Huelva, SW Iberian Peninsula

Fighting '*Spartina* seas'
Flooding, re-burning, cattle, herbicides and/or moving…
Odiel Marshes, Huelva, SW Iberian Peninsula

Volunteers fighting *S. densiflora* in Odiel Marshes