FA1203: Sustainable management of *Ambrosia artemisiifolia* in Europe (SMARTER)

Short Term Scientific Mission Report

Developing a population model for *Ambrosia artemisiifolia*

STSM details

COST STSM Reference Number: COST-STSM-FA1203-15239
Timing of STSM: 1-22 November 2013

Applicant details

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Host details

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Summary of the STSM

In this STSM, we have started to develop a population dynamics model for *Ambrosia artemisiifolia*. We have also designed a protocol for the collection of demographic data to parameterise this model. We will use this model as a tool (i) to quantify and understand the natural variation in the dynamics of common ragweed, and (ii) to prospectively evaluate and compare the long term impact of different management strategies on the population dynamics in a wide range of environments throughout Europe.

Purpose of the STSM

Within SMARTER, new management strategies for the management of *Ambrosia artemisiifolia* are being developed, including biological control. To prospectively evaluate the impact of different management options on the long-term dynamics of ragweed populations in a wide range of environments throughout Europe, a theoretical approach could be useful. The purpose of this STSM was to start to develop a population dynamics model for ragweed, to develop protocols for European-wide data collection to parameterize this model, and to prepare the sessions on this topic in the consecutive SMARTER meeting on Protocols, Models, and Funding (Berlin, 25-27 Nov 2013). This was realised by collaboration with demographic modelling experts Eelke Jongejans and Caspar Hallmann from the Radboud University Nijmegen, Netherlands (the host institution).

Objectives of the STSM

1. Develop a basic plant population dynamics model, including (i) environmental variables and (ii) the impact of biological control agents, using Integral Projection Modelling
2. Run the model with varying parameters (partly based on collected data, partly estimated)
3. Acquire the skills to further elaborate this model
4. Establish further collaboration with the host Eelke Jongejans
5. Protocol development for data collection on plant demography
6. Prepare a discussion about data collection for model input

Description of the work carried out during the STSM

Week 1

- Reading literature about demographic models (matrix models and Integral Projection Models), and different techniques to analyse demographic data (sensitivity analysis, elasticity analysis, life-table-response-analysis).
- Presentation of the COST Action and the research on ragweed population dynamics by Suzanne Lommen in a meeting of the Center for Animal and Plant Population Dynamics.
- Exchange of data collected and methods of data collection used in field populations in Netherlands, Switzerland and Italy.
- Meeting with other Dutch professionals interested in ragweed (see SMARTER Ambrosia survey meeting experts+stakeholders NL), presentation of the COST Action and the research on ragweed distribution and population dynamics by Suzanne Lommen, to discuss the contribution of the Dutch to data collection.

Week 2

- Discussions on the structure of a basic population dynamics model, and parameters to be included.
- Collection of literature and unpublished results to parameterize vital rates used in an initial basic population dynamics model.
- Using RAMAS EcoLab to get a feeling for parameters in demographic matrix models.
- Self-study Integral Projection Models in R.

Week 3

- Make (by Caspar Hallmann) and discuss the first design of a basic population dynamics model of ragweed, discussing model outcomes
- Design a protocol for collection of demographic data on ragweed.
- Follow-up meeting with Floron, the Dutch organisation for vegetation data collection by volunteers, about the involvement of these volunteers as ‘citizen scientists’ in our work.
- Prepare the sessions on population dynamics models for the consecutive SMARTER meeting.
- Discuss future collaboration with the host.

Description of the main results obtained

A population dynamics model for ragweed

We have designed a Periodic Integral Projection Model for the basic population dynamics of ragweed. This model is based on two census data per year, one during the peak of germination (measuring habitat, and individual seedlings in their direct environment), and one during female flowering, before seed dispersal (measuring the same individuals, other individual flowering plants, and the seed soil bank). Vital rates included in this model are germination rate, size- and density-dependent survival and growth rate of seedlings, size-dependent fecundity, and survival of seeds in the seed soil bank.

Data collected in one Dutch ragweed population were used to model seedling survival and growth, and other vital rates were parameterized by data (averages) taken from the literature.

Unfortunately, data from the Swiss and Italian populations could not be used for parameterization, because the populations were only measured in the end of the season, and the majority of the populations was unexpectedly heavily infested by a potential biocontrol agent (see Boriani et al. 2013, Müller-Schärer et al. 2013). Therefore, environmental variables reflecting different habitats and climates could not be included in the preliminary model. However, it was discussed how future data can be used to include these parameters.

An elasticity analysis of this preliminary model indicated that the growth rate is largely affected by the germination rate, confirming our expectation that the seed soil bank dynamics plays a crucial role in the population dynamics of this species.

Modelling skills

I have learnt the basic principles of demographic models and their analysis, and collected literature for future study.

Protocol development

We worked out a detailed protocol for the collection of demographic data to feed the model. We identified a few unresolved issues to be discussed in a larger group of SMARTER in the consecutive meeting.

Preparation of the SMARTER Protocol, Model, and Funding meeting

I prepared several presentations on population dynamics for discussion during the consecutive SMARTER meeting, including 1. The model, 2. The protocol, 3. How to collect data on management impact, 4. How to link this model to other evaluation measures (ragweed distribution data, pollen data). I also organised one half-day session on this topic (cf minutes SMARTER Protocol, Model, and Funding meeting).

Future collaboration with the host institution

We will continue collaboration on population dynamics modelling of ragweed and biocontrol impact. It was agreed that Caspar Hallmann will continue working on the design of the model. I will coordinate the data collection by the SMARTER network (producing a protocol,

organizing a workshop on the application of this protocol, provide infrastructure for data administration, manage the future data base), and process these future data from multiple populations using the model (incorporating environmental effects on vital rates).
Eelke Jongejans is mainly interested in coupling this model to that of population dynamics models of potential biocontrol agents, which was further discussed in the consecutive SMARTER meeting. Both collaborators offered help in further developing my modelling skills in future (e.g. by a follow-up visit).

Other collaborations
We discussed the use and promotion of the iPhone App 'SMARTER Ambrosia Reporter' (to be released in Dec 2013) for the recording of Ambrosia populations by a wide Dutch audience with Johan van Valkenburg (Dutch authority for Food Safety), Herman van Wissen and Maurice Martens (Pollennieuws, platform about allergic pollen / Stichting Flora van Nederland, organisation for the translation of scientific information about the Dutch vegetation to a wide audience), and Boudewijn Odé, Floron (the Dutch organisation for research and protection of the Dutch flora) (cf minutes of the SMARTER Ambrosia survey meeting experts+stakeholders NL).
We further discussed the involvement of 'citizen scientists' in the ragweed population dynamics studies with Odé. He will try to recruit his volunteers for this project. He will organise an information stand about ragweed studies in relation to SMARTER on the jubileum day of the organisation, 13 December 2013. He will also contact colleagues in Bulgaria to see if they are interested to join the research.

Foreseen publications/articles resulting from the STSM
Joint studies will result in joint publications. We consider publishing the modelling approach and the preliminary population dynamics model in a scientific journal.

Confirmation by the host institution of the successful execution of the STSM
Cf. attached email by the host.

From: Eelke Jongejans [mailto:e.jongejans@science.ru.nl]
Sent: mardi 10 décembre 2013 21:13
To: maurizio.vurro@ispa.cnr.it
Cc: LOMMEN Suzanne
Subject: COST-STSM-FA1203-15239

Dear Dr. Maurizio Vurro,

I would like to confirm that Dr. Suzanne Lommen has visited my lab in Nijmegen for 3 weeks in November 2013. I have read the final draft of her STSM report and fully agree with the content of that report. Her visit was a productive one and we have made good progress in setting up models of the population dynamics of *Ambrosia artemisiifolia*. I anticipate that a follow-up visit by her will allow us to finalize model construction and to start drafting a scientific paper about the model. Needless to say that she is very welcome to visit Nijmegen again in the near future.

with kind regards,
Eelke Jongejans

Acknowledgements

I greatly acknowledge the contribution of the host to the scientific discussions on this work. I also thank the host and his colleagues and collaborators I got to know for the great hospitality I experienced during my stay. I am looking forward to the continuation of our collaboration.

Fribourg, 3 December 2013
Suzanne Lommen

References cited

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Müller-Schärer H, Lommen STE, Rossinelli M, Bonini M, Boriani M, Bosio G, Schaffner U. The ragweed leaf beetle has successfully landed in Europe: fortunate coincidence or threat? Weed Research (in press).