Vitenskapskomiteen for mattrygghet
Norwegian Scientific Committee for Food Safety

Assessment of the probability of establishment of winter wild oats (*Avena sterilis* ssp. *ludoviciana*) in Norway

Opinion of the Panel on Plant Health
of the Norwegian Scientific Committee for Food Safety
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SUMMARY

Wild oats (*Avena fatua* L.) are widely spread and constitute a weed problem in Norway. In order to identify proper revision of the current policy on wild oats in Norway, the Norwegian Food Safety Authority (Mattilsynet), in a letter of 27th March 2007, requested a pest risk assessment from the Norwegian Scientific Committee for Food Safety (VKM). Mattilsynet also asked for an assessment of the probability that other species than *A. fatua* (other wild oats species with saucer-shaped abscission scar) can establish as a weed in Norway. The current document is an assessment of the probability that other species than *A. fatua* can establish as a weed in Norway, made by VKM's Panel on plant health (Panel 9). The assessment is based on a report from the Norwegian Institute for Agricultural and Environmental Research (Bioforsk). Panel 9 gives the following main conclusions of the assessment: 1) The main *Avena* species that are important weeds of cereal and arable crops include *A. fatua* L., *A. sterilis* and *A. barbata* Pott. All three species have an abscission scar on the grains. 2) A risk assessment of *A. fatua* L. as an indirect pest in Norway is given in a separate document. For both *A. sterilis* ssp. *macrocarpa* and ssp. *maxima*, and for *A. barbata* Pott, the potential for entry and establishment in Norway is considered as very low. *A. sterilis* ssp. *ludoviciana* (winter wild oats) has a moderate potential for establishment in Norway. The suitability of the environment for *A. sterilis* ssp. *ludoviciana* was therefore investigated. 3) While it is highly likely that the probability of establishment of *A. sterilis* ssp. *ludoviciana* has increased in Norway in recent years due to climate change and consequent changes in cultural practices, its probability of establishment in Norway is still low. It is therefore not likely that it will become a weed in Norway under current conditions. 4) However, if the future climate of the PRA area changes so that winter conditions become similar to conditions in southern England, while the acreage of winter cereal continues to grow, *A. sterilis* ssp. *ludoviciana* could become a weed in Norway. 5) *A. sterilis* ssp. *ludoviciana* is not present in Denmark, where winter cereals are much more widely cultivated, and the climate is more favourable than in Norway. One would therefore expect the weed to establish in Denmark before it becomes a problem in Norway.

KEY WORDS

Avena fatua L.; *Avena barbata* Pott; *Avena sterilis* ssp. *ludoviciana*; *Avena sterilis* L. ssp. *macrocarp*; *Avena sterilis* L. ssp. *maxima*; winter wild oats; establishment potential; CLIMEX

ASSESSED BY

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VKM has asked the Norwegian Institute for Agricultural and Environmental Research (Bioforsk), Plant Health and Plant Protection Division, to make a draft assessment of the probability that other species than *A. fatua* (other wild oats species with saucer-shaped abscission scar) can establish as a weed in Norway. VKM has used this report (Netland et al. 2008b) as a basis to answer the request from the Norwegian Food Safety Authority (Mattilsynet).

Jan Netland, Helge Sjursen and Trond Rafoss are acknowledged for their valuable work with the draft assessment.

CONTENTS

1. BACKGROUND

Wild oats (*Avena fatua* L.) are widely spread and constitute a weed problem in Norway. Wild oats compete strongly with cereal crops because of their similar biology and growth habit, and the weed can cause significant crop yield losses when left unmanaged.

Mattilsynet has a register comprising all properties where wild oats has been found. 9526 agricultural properties were registered with wild oats by the end of year 2005. *A. fatua* is the only species of wild oats that via the registrations so far has shown to be a weed problem in Norway.

In order to revise the current policy on wild oats in Norway, Mattilsynet, in a letter of 27th March 2007, requested a pest risk assessment on wild oats in Norway. Mattilsynet also asked for an assessment of the probability that other species than *A. fatua* (other wild oats species with saucer-shaped abscission scar) can establish as a weed in Norway. To answer the request from Mattilsynet, VKM commissioned two separate draft assessment reports from Bioforsk. The first report is a draft pest risk assessment of *A. fatua* (Netland et al. 2008a), which has been used as a basis for VKMs pest risk assessment (VKM 2008). The second report is a draft assessment of the establishment potential of winter wild oats (Netland et al. 2008b), which has been used as a basis for the current document. The current document is an answer to Mattilsynet's second request in terms of reference: An assessment of the probability that other species than *A. fatua* (other wild oats species with saucer-shaped abscission scar) can establish as a weed in Norway.

Be aware that the current document is not a Pest Risk Analysis (PRA). However, since this assessment is part of a PRA process, the current document refers to the PRA term in some contexts, like the identification of the PRA area.

2. TERMS OF REFERENCE

Mattilsynet requests a risk assessment of wild oats, *Avena fatua* L. as an indirect plant pest in Norway. The pest risk assessment should be made according to ISPM No. 11 (FAO 2004). It should also include an assessment of the probability that other species than *A. fatua* (other wild oats species with saucer-shaped abscission scar) can establish as a weed in Norway.

3. INITIATION

3.1. Initiation points

3.1.1. Identification of a pest that may require phytosanitary measures

This assessment on establishment potential was initiated by Mattilsynet, by identification of a pest that may require phytosanitary measures.

3.2. Identification of PRA area

The assessment area is Norway.

3.3. Information

Information sources utilised for this assessment are published material available in international scientific journals, books and reports, and on the Internet, and personal communications and geographic data that have been made available to the risk assessors. Where these information sources have been used, this is indicated in the text by references enclosed in brackets.

The current assessment is not a complete pest risk assessment, but follows the structure according to ISPM 11 (FAO, 2004) of a pest risk assessment for the subtopics covered.

3.3.1. Previous PRAs

No pest risk assessments, PRAs or other relevant assessments of *Avena* species with saucer-shaped abscission scars exist for the PRA area (Norway).

3.4. Conclusion of initiation

The pests of concern in this assessment are other species than *A. fatua* (other wild oats species with saucer-shaped abscission scar) that might establish as a weed in Norway. The initiation point for this assessment is identification of a pest that may require phytosanitary measures. The PRA area is Norway. No previous PRAs or other relevant assessments are known that can replace this assessment.

4. PEST RISK ASSESSMENT

4.1 Pest categorization

4.1.1. Identity of pest

4.1.1.1 Scientific name and taxonomic position

The following *Avena* species with a saucer-shaped abscission scar (apart from *A. fatua* L.) are included in the current assessment:

Avena sterilis L. ssp. *ludoviciana*

Avena sterilis L. ssp. *macrocarpa*

Avena sterilis L. ssp. *maxima*

Avena barbata Pott.

Jones (1976) has classified this group as the weedy *Avena* species.

4.1.1.2 Synonym

A. sterilis ssp. *maxima* is by some authors considered as synonymous with *A. sterilis* ssp. *ludoviciana* (Jones 1976).

4.1.1.3 Common names

There are no established Norwegian names for *A. barbata* or any of the *A. sterilis* subspecies.

English names:

A. sterilis L. ssp. *ludoviciana*

- winter wild oats
- animated wild oats
- red wild oats

A. barbata

- slender wild oats

A. sterilis L. ssp. *macrocarpa* and *A. sterilis* ssp. *maxima*

In Bond et al. (2007) *A. sterilis* L. ssp. *macrocarpa* is also called winter wild oats. If one considers *A. sterilis* ssp. *maxima* as synonymous with *A. sterilis* ssp. l*udoviciana*, like Jones (1976), this subspecies can also be called winter wild oats. However, in the current assessment the common name "winter wild oats" is used on *A. sterilis* L. ssp. *ludoviciana* only, unless otherwise is specified.

We can not find any other specific English name for *A. sterilis* L. ssp. *macrocarpa* or *A. sterilis* ssp. m*axima*.

4.1.1.5 Biological information

While *A. fatua* and *A. barbata* shed all the ripe seeds of the spikelets separately, *A. sterilis* ssp. *ludoviciana* sheds all the ripe seeds in the spikelets together as a unit. 90% of the viable seeds of *A. fatua* and 0-50% of the seeds of *A. barbata* are dormant at harvest. The first seeds of *A. sterilis* ssp. *ludoviciana* are not dormant at harvest, while the 2nd and 3rd seeds are dormant (Jones 1976). The seed dormancy enables the species to survive sub-optimal conditions, e.g. periods of grass leys.

In UK the main period of seedling emergence for *A. sterilis* ssp. *ludoviciana* is from October to March with a peak around November-December. Winter wild oats germinate predominantly in winter or early spring. The most favourable temperatures for germination are between 7 and 13°C (Thurston 1976; Bond et al. 2007). This range in temperatures may occur at planting time of winter wheat in Norway (from the first week of September to the first week of October). Fernandez-Quintanilla et al. (1986) report that the winter survival in Spain ranged from 31-81 % and that one of the major causes of mortality was frost stress.

4.1.2 Occurrence of Avena species

The main *Avena* species that are important weeds of cereal and arable crops include wild oats, *A. fatua* L., *A. sterilis* and *A. barbata* Pott. All three species have an abscission scar on the grains (Jones 1976).

A. fatua L. is widely distributed in Norway. A separate pest risk assessment of *A. fatua* L. is given by VKM (2008).

A general map of the distribution shows that *A. sterilis* is distributed in southern England, in central Europe, and the Mediterranean and Middle Eastern countries (Baum 1977). In the UK, *A. sterilis* ssp. *ludoviciana* has become a major weed on heavy soils in central, southern and eastern England, possibly reflecting the distribution of winter wheat. In Italy, winter wild oats are represented by two subspecies, *A. sterilis* ssp. *ludoviciana* and *A. sterilis* ssp. *macrocarpa* (Bond et al. 2007). A third subspecies, *A. sterilis* ssp. *maxima*, is by some authors considered as synonymous with *A. sterilis* ssp. *ludoviciana* (Jones 1976).

There is some doubt about the status of *A. barbata* as a weed of cereals in the Mediterranean and Middle Eastern countries (Jones 1976), where the species has its main distribution (Baum 1977).

4.1.4 Potential for establishment and spread in PRA area

<u>*A. sterilis* subspecies:</u>

For both *A. sterilis* ssp. *macrocarpa* and ssp. *maxima* the potential for entry and establishment in Norway is very low. Their current geographical distributions are in the Middle East and Mediterranean area, which have climatic conditions very different from the PRA area. Major pathways for entry are not likely to exist, because seed cereals are not imported from the Mediterranean area to the PRA area. A minor pathway like bird seeds is still a possibility, but combined with a low potential for establishment this constitutes a low potential of introduction.

The subspecies *A. sterilis* ssp. *ludoviciana* has the closest geographical distribution to Norway. Temperatures within the range required for germination may also occur at planting time of winter wheat in Norway. In southern parts of Norway, the winter begins during November-December, with low temperatures or frost. However, as the need for winter

hardiness in Spain is low (Fernandez-Quintanilla et al. 1986) one can expect that the probability that seedlings of this species will survive in Norway is moderate. Major pathways for entry are not likely to exist, because Norway does not import seed cereals from the UK or the Mediterranean area. A minor pathway like bird seeds is still a possibility.

A. barbata:

Since this species is distributed in the warm Mediterranean and Middle Eastern countries, the potential for entry and establishment in the considerably colder Norway is very low.

4.1.6 Conclusion of pest categorization

Of the candidates assessed, only *A. sterilis* ssp. *ludoviciana* has a moderate potential for entry and establishment in Norway. For the other species/subspecies the possibility for entry and establishment in Norway is very low. This assessment will therefore only investigate the suitability of the environment for *A. sterilis* ssp. *ludoviciana*

4.2. Assessment of the probability of establishment of *A. sterilis* ssp. *ludoviciana*

4.2.1 Suitability of the environment for A. sterilis ssp. *ludoviciana*

Winter cereal production, at its current extent, is a relatively new agronomic practice in Norway. Development of improved winter cereal varieties combined with more favourable (milder) winters have increased the potential for winter cereals in Norway. Climate is an important limiting factor for species such as winter wild oats because winter hardiness is needed to survive the Norwegian winter climate. The examination of the suitability of the environment therefore concentrates on the analysis of climate.

An analysis of the suitability of climate for *A. sterilis* ssp. *ludoviciana* in the PRA area of Norway was done with the Match Climates function in CLIMEX version 2 (Sutherst & Maywald, 2001). This function compares the climates of different locations to provide a rough assessment of the pest establishment potential. The Match Climates function in CLIMEX searches the long-term meteorological database for locations with climates similar to that of a given location ("Home"). The level of similarity is given by the “Composite Match Index” (CMI), which is the product of six component indices indicating similarity in the climate variables maximum temperature, minimum temperature, total rainfall, relative humidity, rainfall pattern and soil moisture. Each of these component indices can range between 0 and 1, with a value of 1 indicating an exact match with the "Home" location. All indices can be weighted individually (using Match Index Weights) to emphasise the more important variables. The default weight setting is 1.0 for each index, except the indices for relative humidity and soil moisture, which have a default weighting of zero. In this analysis the default weighting was used.

The strategy for assessing climatic suitability for winter wild oats in Norway was to select, from the CLIMEX meteorology database, the geographically closest area to Norway where winter wild oats is known to occur and constitute a pest problem. Southern England and the region of Oxford were identified to fill these criteria. CLIMEX uses the terminology “H” for “Home” area, which is Oxford (UK) in this analysis, and “A” for “Away”, which is locations in the PRA area. For CLIMEX two meteorology databases with a global coverage are available. One is weather-station records (point data) for the official normal period 1931–

1960 (Sutherst & Maywald, 2001). The other is a gridded climatology dataset for the subsequent and most recent available official normal period (1961–1990). The concept of "normal period" is defined by the World Meteorological Organization to describe the climate for a location for a certain period in history. The next official normal period will be 1991-2020. The gridded dataset for 1961-1990 is available at two different spatial resolutions, 0.5 degrees and 10 minutes latitude x longitude resolution (New et al. 2002). In the following analysis both the database with weather station data (1931–1960) and the climatology grid (1961-1990) with the finest resolution were used. Thus, the climate of Oxford was compared with that of Norway in two ways. In the first approach the meteorological station database (1931–1960) was used to compare Oxford with Norway and produce a map (Figure 1) and a table for CMI for the Norwegian locations (Table 1). Climograms for air temperature and precipitation were produced for the selected locations Oslo, Lillehammer and Trondheim, representing the main cereal growing areas (Figure 2). The second approach was to compare the Oxford climate by selecting a grid cell covering the Oxford area from the 1961 -1990 climatology grid and comparing with the climatology grid by New et al. (2002) covering Europe (extract from this displayed in Figure 3).

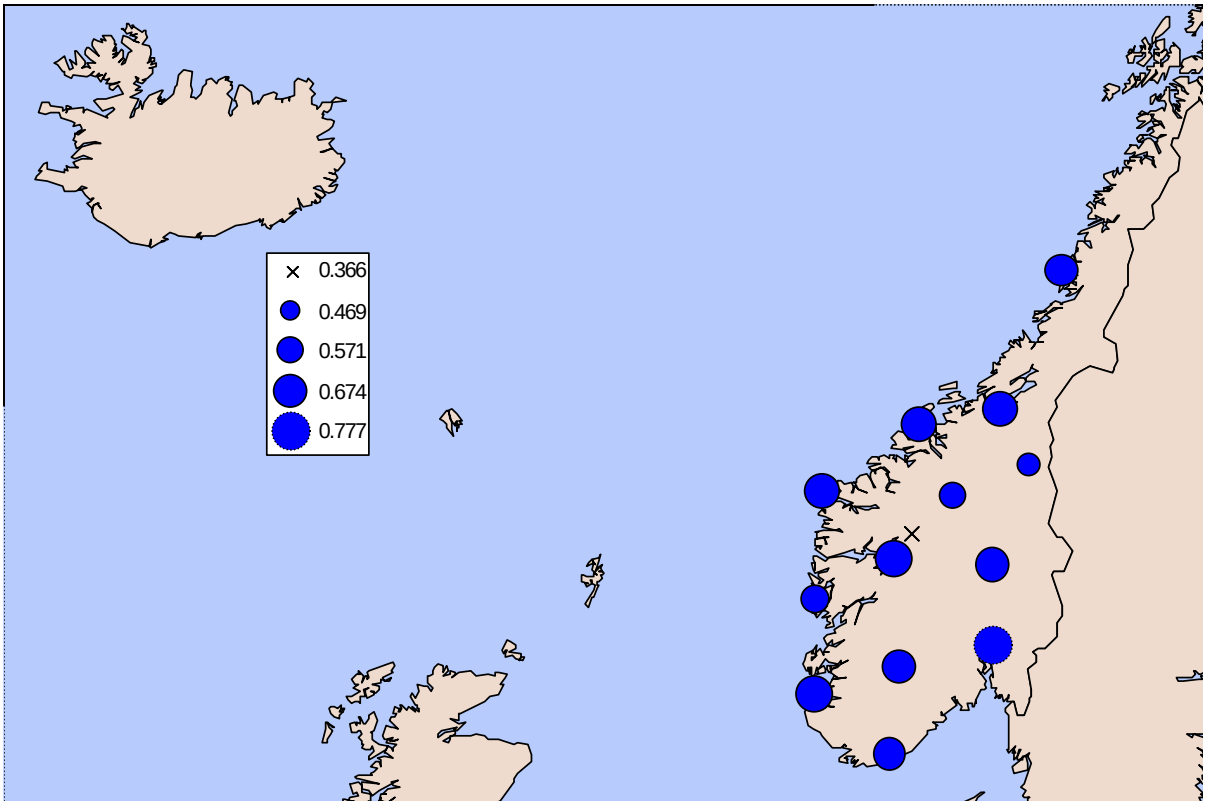

Figure 1 Composite match index (CMI) for locations in Norway compared to Oxford (UK) based on 1931 – 1960 average meteorological station data. Blue symbols indicate relative sizes of CMI values.

Table 1 Composite climate match indices for Norwegian locations when compared to Oxford based on 1931- 1960 averages

Location	Composite Match Index (CMI)	CMI climate change (+ 2°C)
Oslo	0.78	0.80
Stavanger	0.75	0.76
Lærdal	0.75	0.81
Kristiansund	0.71	0.75
Trondheim	0.70	0.81
Lillehammer	0.70	0.76
Dalen	0.68	0.74
Kristiansand	0.66	0.72
Brønnøysund	0.66	0.75
Bergen	0.60	0.61
Dombås	0.57	0.65
Røros	0.52	0.59

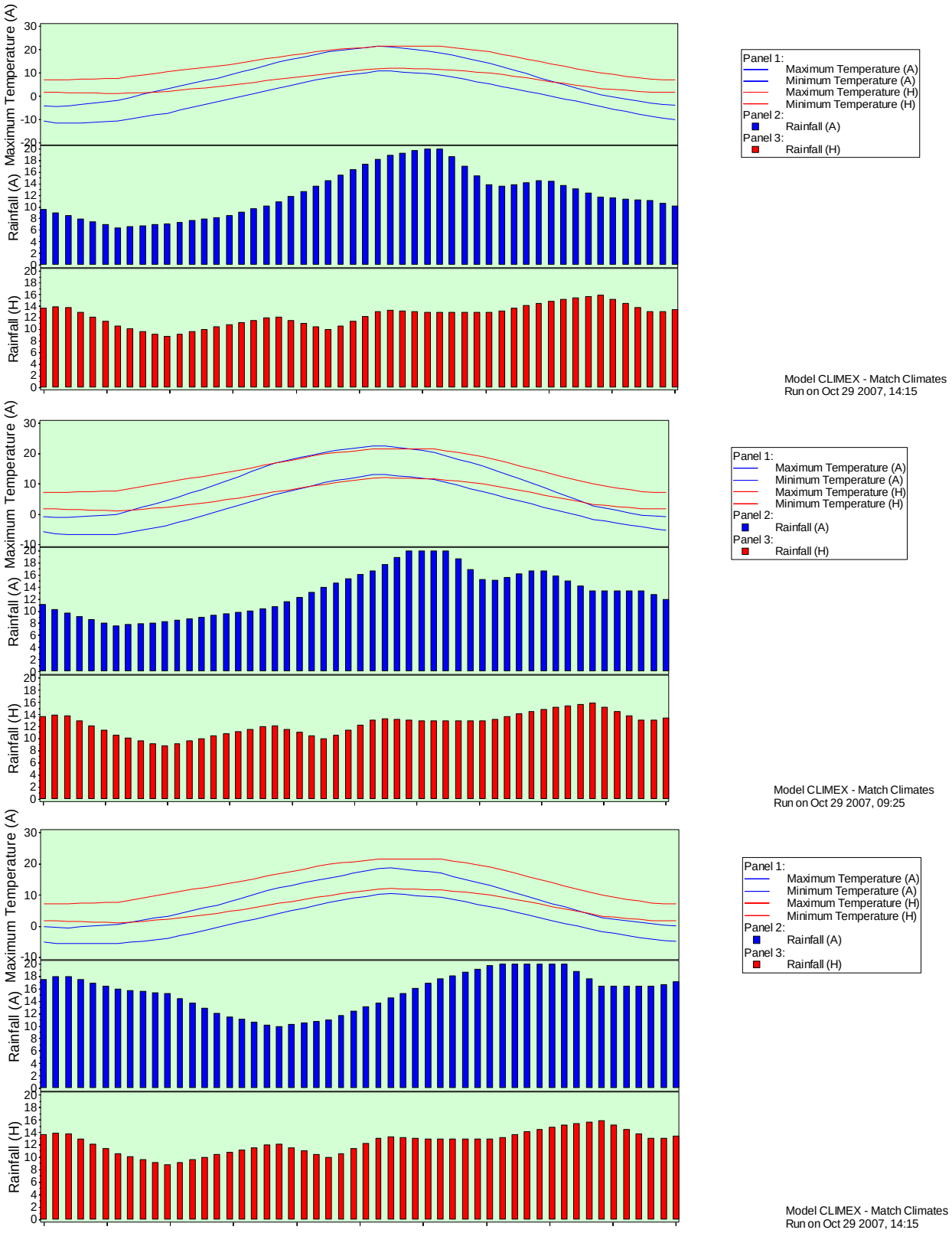

Figure 2 Climate comparison of weekly (week 1 to 52 on x-axis) air temperatures (°C) and rainfall (millimetres) between Oxford (UK) and Lillehammer (top), Oslo (middle) and Trondheim (bottom), based on 1931- 1960 averages. In the graphs (H) refers to Oxford and (A) to Lillehammer, Oslo or Trondheim.

The results from climate matching of Oxford with Norway reveal a CMI in the range from 0.52 to 0.78. However, the locations representing the main cereal growing regions, Oslo, Lillehammer (southeast Norway), and Trondheim (mid-Norway), have indices around 0.7 (Figures 1 and 3, and Table 1). In general, the Norwegian locations have lower winter temperatures than Oxford, whereas the rainfall ranges from similar to higher. This is shown in more detail in Figure 2, which indicates that the main difference in climate is due to lower winter temperatures in Norway (far left and far right of the x-axis in Figure 2).

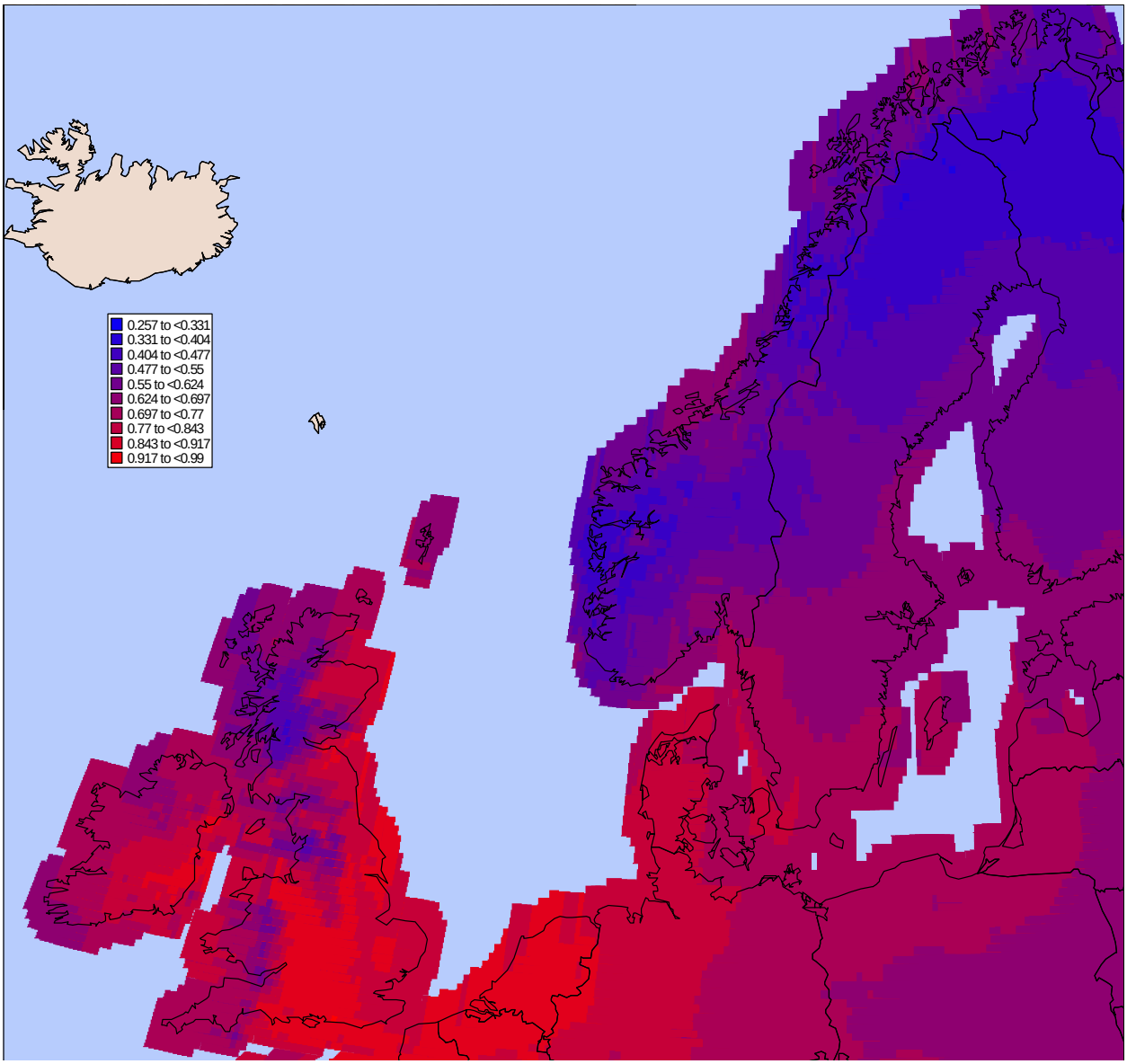

Figure 3 Composite Match Index between the Oxford area in the United Kingdom and the 1961 - 1990 climatology grid available for CLIMEX.

As mentioned earlier, the most recent climate database in CLIMEX is based on the last available official normal period (1961–1990). However, the climate in the years after has changed, and it is therefore found appropriate to include a scenario of +2°C in this analysis. The effect of an increased temperature on CMI is displayed in Table 1 and Figure 4. It can be

observed that the areas with the best match move north into Denmark and into Scotland in the United Kingdom, but still not to Norway.

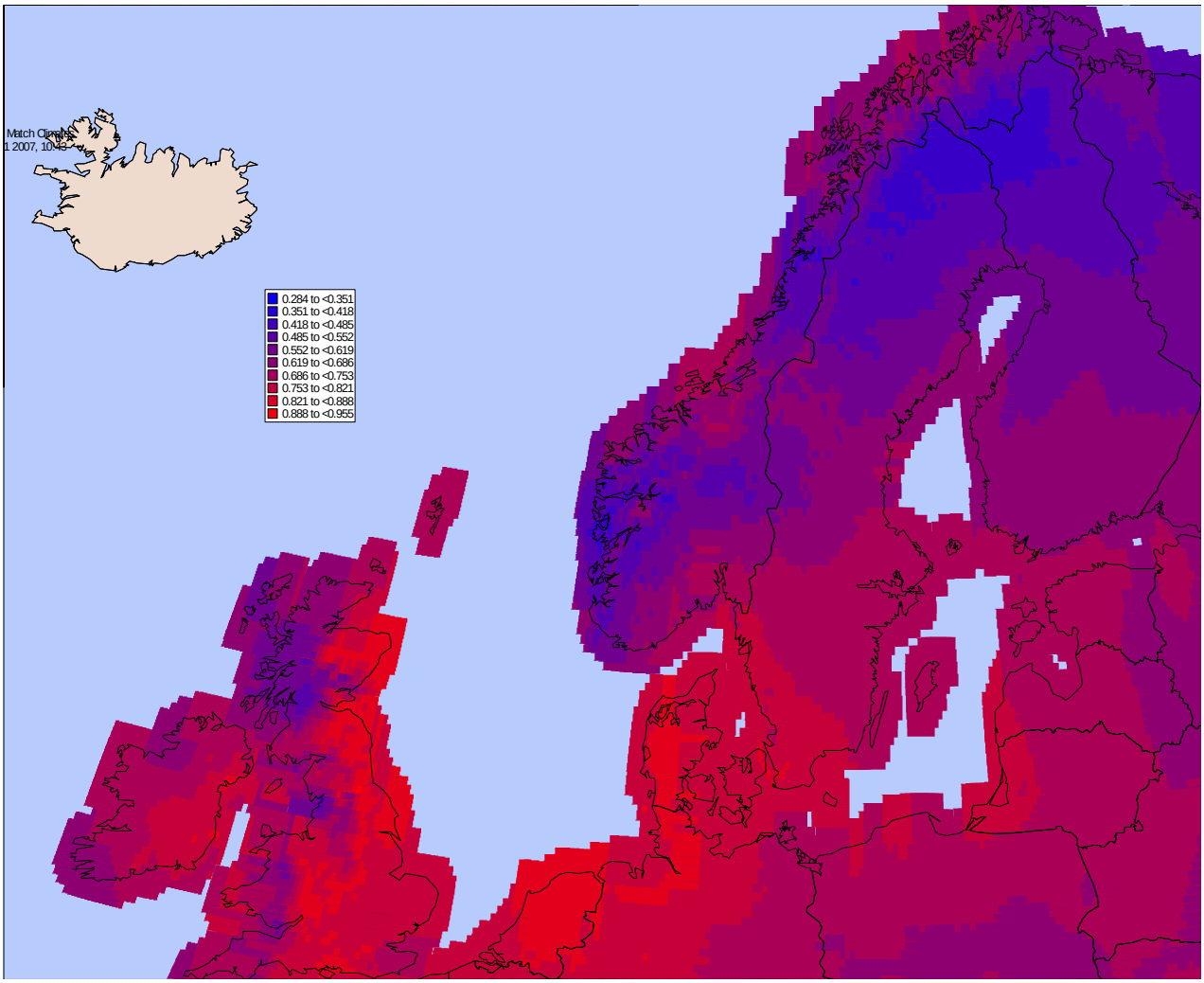

Figure 4 Climate change of + 2°C and Composite Match Index between Oxford and the 1961 - 1990 climatology grid available for CLIMEX.

4.2.2 Cultural practices and control measures

In the UK winter wild oats are mainly connected with winter cereals, because winter wild oats mainly germinate in the autumn (Bond et al. 2007). Based on experiences in UK, the change in cultural practice in Norway, with increased growing of winter cereals, increases the potential for establishment of winter wild oats (Bond et al. 2007). This is simply because the agronomic practices applied in winter cereal growing facilitate germination and growth conditions for winter wild oats.

4.2.3 Other characteristics of the pest affecting the probability of establishment

Bond et al. (2007) state that *A. sterilis* ssp. *ludoviciana* is a greater weed problem in southern Europe than in the UK. Although present in the UK since 1926, in the most important cereal growing area in central southern England, *A. sterilis* was found in only 7 % of winter wheat, 3 % of winter barley and 1 % of spring barley fields.

According to our knowledge and based on a literature search, *A. sterilis* ssp. *ludoviciana* is not present in Denmark. Denmark displayed a better match with the Oxford climate and has a higher portion of winter cereal in the crop rotation than Norway. One would therefore expect the weed to establish in Denmark before Norway.

4.2.4 Endangered area

We conclude that at present no parts of Norway are endangered by *A. sterilis* ssp. *ludoviciana*.

4.4. Degree of uncertainty

The current assessment of establishment probability is based on a very rough methodology for assessment of climatic establishment potential, and inherently associated with a high degree of uncertainty. The method used and implemented in CLIMEX is a general purpose method that will of course have shortcomings regarding its ability to catch and describing organism specific climate requirements. Moreover, the spatial resolution in the database is too low to detect more favourable microclimates in a PRA area. Another serious shortcoming of the methodology is the availability of recent climate information. Because of climate change, even climate information from the most recent official normal period is becoming outdated.

On the other hand, we consider the uncertainty in the climate comparison results to be low, in light of the relatively strong knowledge of the pest's establishment in the UK and southern Europe.

5. CONCLUSION AND SUMMARY

The main *Avena* species that are important weeds of cereal and arable crops include *A. fatua* L., *A. sterilis* and *A. barbata* Pott. All three species have an abscission scar on the grains.

A risk assessment of *A. fatua* L. as an indirect pest in Norway is given in a separate document.

For both *A. sterilis* ssp. *macrocarpa* and ssp. *maxima*, and for *A. barbata* Pott, the potential for entry and establishment in Norway is considered as very low.

A. sterilis ssp. *ludoviciana* (winter wild oats) has a moderate potential for establishment in Norway. The suitability of the environment for *A. sterilis* ssp. *ludoviciana* was therefore investigated:

Our assessment of the probability of establishment indicates that the climate is not favourable for establishment of *A. sterilis* ssp. *ludoviciana* in Norway.

A. sterilis ssp. *ludoviciana* is a problem in southern Europe and central southern England and is mainly a weed in winter cereals. While it is highly likely that the probability of establishment of *A. sterilis* ssp. *ludoviciana* has increased in Norway in recent years due to climate change and consequent changes in cultural practices, its probability of establishment

in Norway is still low and it is therefore not likely that it will become a weed in Norway under current conditions. However, if the future climate of the PRA area changes, so that winter conditions become similar to conditions in southern England, while the acreage of winter cereal continues to grow, *A. sterilis* ssp. *ludoviciana* could become a weed in Norway

A. sterilis ssp. *ludoviciana* is not present in Denmark where winter cereals are much more widely cultivated, and the climate is more favourable than in Norway. One would therefore expect the weed to establish in Denmark before it will become a problem in Norway

6. REFERENCES

Baum, B.R. 1977. Oats: wild and cultivated. A monograph of the genus *Avena* L. (*Poaceae*). Biosystematics Research Institute, Canada Department of Agriculture, Research Branch, Ottawa, Ontario, Canada. Monograph No. 14. 463 pp. ISBN 0-660-00513-1.

Bond, W., Davies G. & Turner, R. 2007. The biology and non-chemical control of Winter Wild-oat (*Avena sterilis* ssp. *ludoviciana*). See link: http://www.gardenorganic.org.uk/organicweeds/downloads/avena%20ludoviciana.pdf

Fernandez-Quintanilla, C., Navarrete, L., Andujar, J.L.G., Fernandez, A. & Sanchez, M.J. 1986. Seedling recruitment and age-specific survivorship and reproduction in populations of *Avena sterilis* L. ssp. *ludoviciana* (Durieu) Nyman. *Journal of Applied Ecology*, Vol. 23, No. 3: 945-955

FAO, 2004. Pest Risk Analysis for Quarantine Pests, Including Analysis of Environmental Risks and Living Modified Organisms. International standards for phytosanitary measures (ISPM) No. 11. Food and Agriculture Organisation of the United Nations, Rome.

Jones, D.P. 1976. Wild Oats in World Agriculture. An Interpretative review of World Literature. Agricultural Research Council, London. ISBN 0-7084-18-3.

Netland, J., Sjursen, H. & Rafoss, T. 2008a. Wild oats in Norway – Draft pest risk assessment report on wild oats in Norway. *Bioforsk Report* Vol. 3, No. 3.

Netland, J., Sjursen, H. & Rafoss, T. 2008b. Draft assessment of establishment potential for winter wild oats in Norway. *Bioforsk Report* Vol. 3, No. 4.

New, M., Lister, D., Hulme, M. & Makin, I. 2002. A high-resolution data set of surface climate over global land areas. *Climate Research* Vol 21: 1-25

Sutherst, R.W. & Maywald, G.F. 2001. CLIMEX version 2. Hearne Scientific Software Pty. Ltd. Melbourne, Australia.

Thurston, J.M. 1976. Weeds in cereals in relation to agricultural practices. *Annals of Applied Biology* 83: 338-341.

VKM. 2008. Pest risk assessment of wild oats (*Avena fatua*) as an indirect plant pest in Norway. Opinion of the Panel on plant health of the Norwegian Scientific Committee for Food Safety. VKM document No. 07/906-5. ISBN 978-82-8082-294-9.