PEST RISK ANALYSIS (PRA) TRAINING

Presentations with Speaker's Notes

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Claire Wilson, Andrea Sissons, Louise Dumouchel, Lesley Cree (Canadian Food Inspection Agency, Canada), Alan MacLeod (Central Science Laboratory, United Kingdom), Mike Ormsby (New Zealand Ministry of Agriculture and Forestry, New Zealand), Gritta Schrader (Federal Biological Research Centre, Germany), Stacie Johnston (IPPC Secretariat), DDK Sharma (Ministry of Agriculture, India), Velia Arriagada (Servicio Agrícola y Ganadero, Chile), and Ryan Hill (Secretariat of the Convention on Biological Diversity).

INTRODUCTION

The material in this manual consists of a complete set of speaker's notes and slides for the 14 lectures that make up the IPPC PRA training course. The speaker's notes in this manual are meant to be used by the instructors when preparing their talks and are guidelines for how one might deliver each lecture. Instructors can choose to use the speaker's notes if they wish or they can add or modify material based on the particular needs of country receiving the training.

The accompanying CD contains PowerPoint presentations of each these lectures. Each PowerPoint presentation has speaker's notes associated with it that are suitable for printing and using as class handouts. These speaker's notes are mostly similar to the ones in this manual and they cover the material on the slide but they do not go into as much detail on suggested ways of presenting the material as the speaker's notes in this manual do. Instructors may also choose to provide the slides as handouts without the speaker's notes if they wish participants to take their own notes.

IPPC and its Relationship to PRA

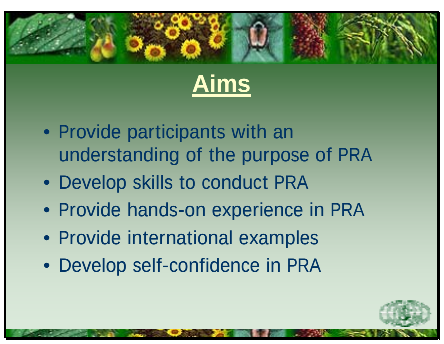
Slide 1

Slide 2

This slide can be used during the welcome and introductions on the first day.

The course was developed by an international working group who met in Ottawa Canada in October 2006. The group has members from Canada, Chile, Germany, New Zealand and the UK, as well as from the IPPC secretariat in Rome.

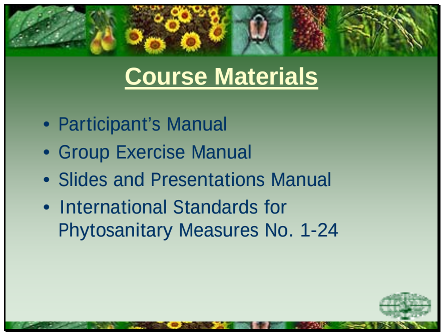
Slide 3



This is an introductory level course on Pest Risk Analysis and its aims are to:

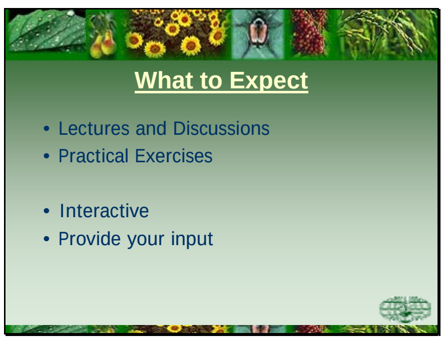
- Provide participants with an understanding of the purpose of PRA
- Develop skills to conduct PRA
- Provide hands-on experience in PRA through exercises
- Provide international examples of PRA and
- Develop self-confidence in PRA

Slide 4



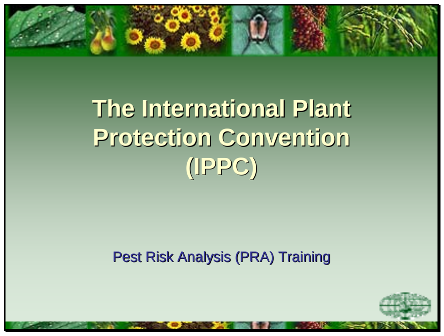
The materials we will use today include a participant's manual with background information on the material being discussed. This manual has many examples throughout it and goes into more detail on the material being covered in the lectures. It is meant to be a reference manual for you to use during and after the course. We will refer you to the appropriate page numbers in this manual during each lecture so that you can make notes in it if you wish. There is also a group exercise manual which contains all of the exercises for the group breakout sessions, and there is a manual that contains all the PowerPoint presentations with room for you to make notes beside them as we go through the lectures. Also you have the ISPM's book which is again a valuable resource for you to use both during and after this course.

Slide 5



This is the last slide for the introductory speech, next is the first lecture on IPPC.

Slide 6



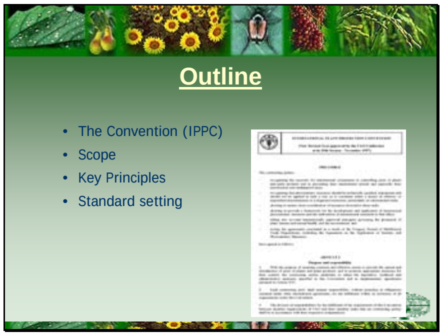
The purpose of this talk is to provide the overall context in which PRA is conducted. Not all students will have the same background or knowledge of the IPPC or the WTO-SPS Agreement and where PRA (and hence he/she) fits into that international context. If the group is relaxed and comfortable with each other, you might even be able to open this presentation by asking them about their level of comfort and understanding of the international context for PRA; if things are still pretty formal, maybe its best just to open by explaining the purpose of this talk and plunge right in.

Not all IPPC countries are also WTO members, so it is important to find out before beginning the training, if the participants will be members of WTO also, or solely members of IPPC. For the rest of the course, it's not really critical, but it would be better to know and to tell the participants (who may not know themselves), than to have to skirt around the issue or not have the correct information if the question arises.

Lists of the members of IPPC can be found on the IPPC web-site and members of the WTO are listed on the WTO web-site. As new members are added to each list pretty regularly, it is important to check the sites in the weeks or months leading up to the course for up-to-date membership lists. Naturally, the host country and participants will be members of the IPPC, but the length of time that they have been members will vary considerably; it is the question of their additional membership in the WTO that is most in question here.

The Convention on Biological Diversity (CBD) and the Cartegena Protocol are both mentioned very briefly in this presentation, and again, it might be helpful to know if the participants are representing countries that are members of one or both of these agreements. The information on both is available from the CBD web-site.

Slide 7



Note to presenter: this slide and the next are just outlining what will be covered in the talk; it is not necessary to spend anytime on anything in particular as it will all be covered in the subsequent slides. The subsequent slide is identical except that the WTO header will appear on top of the IPPC document.

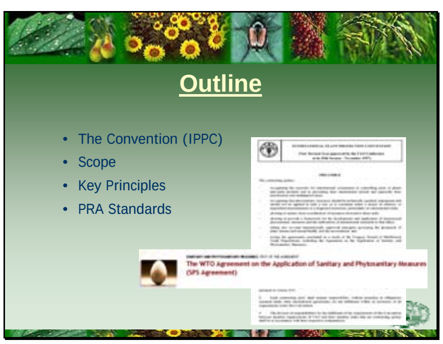
Points:

Throughout this section I/we will touch on several aspects of the IPPC and answer many questions about the IPPC:
What is the IPPC?
What is its position internationally?
How does it fit with other international agreements?

Focus on IPPC

- What is its purpose and scope?
- What are the key principles of the IPPC?
- How are the key principles supported by the IPPC and met by contracting parties?
- When are international standards developed?
- Who develops them and what is their purpose?

Slide 8



We will also talk about the WTO-SPS Agreement.

Slide 9

Note to speaker: The point of this slide is to stress that the participants are part of an initiative that is very global and they are not alone in conducting PRAs or developing phytosanitary requirements based on PRA. It may be helpful for the participants to see where you and the other presenters come from and that you know where they come from, so you may wish to use a pointer to indicate, more or less, where you and the others come from etc.

Points:

The IPPC is an international agreement that binds contracting parties to the obligations of the convention. The IPPC also acts as a source of guidance by creating international standards and guidelines. As of October 2006, the IPPC involved 159 contracting parties.

Over 80% of the countries in the world are members, though initially actions to prevent transfer of pests between countries started as a very small idea.

1660: 1st legislation (Rouen, black stem rust)
1878: 1st international legislation (grapevine phylloxera)
1951: International Plant Protection Convention
1979: 1st revision of the IPPC
1991: 1st revision of the IPPC comes into force
1994: World Trade Organization Sanitary and Phytosanitary Agreement (WTO-SPS) adopted including recognition of the IPPC
1993: 1st IPPC Standard
1997: 2nd revision of the IPPC
1998: 1st ICPM meeting
2006: 2nd revision of the IPPC comes into force
2006: 1st CPM meeting

The IPPC does many things which we will learn about over the course of the next week. Probably its best known and arguably its most important role is in developing standards which can then be used by member countries to ensure that they are following the principles of the IPPC, protecting their own plant resources and also preventing the movement of plant pests.

Slide 10

Note to speaker: in addition to reviewing the aims of the IPPC here, this is an opportunity to make the IPPC (and hence PRA) a personal thing, to encourage participants to take pride in being part of such an important cause, that of protecting the plants in their country and facilitating safe trade in plants and plant products between countries. The aims of the IPPC can sound a little far away and lofty, but if the presenter inserts a little example from his/her own country or the host country, then the aims become more tangible for the participants. This takes a little advance preparation, but should not be too onerous. Its just a quick one-line scenario (the picture shows a peach infected with plum pox virus, a virus which threatens the productivity of peaches and other species of *Prunus*; if the host country, for example, grows a lot of plums, peaches, or other *Prunus* fruits, explaining the picture might all that is needed to make the aims personal for them.)

Points:

The IPPC aims to do three things ...

Prevent introduction and spread of pests – we have all had experience in our countries of the effects of introduced pests on our agriculture, forests or other natural areas. Very often this introduction has occurred as a consequence of human activities, such as importing or exporting plant products, or other goods.

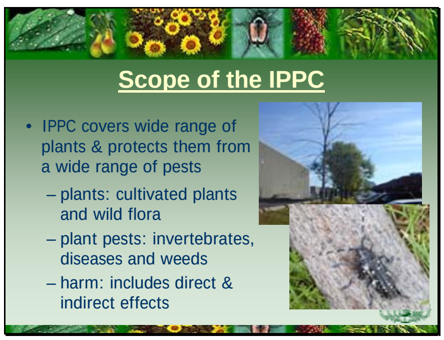
Historically, when people moved from one part of the world to another, they took with them the food and other plants that they were familiar with, and unintentionally also brought pests. In more modern times, international trade in plants and plant products has become an important part of the economies of individual countries introducing more and more opportunities for the spread of pests.

Thus this important first aim of the IPPC is balanced by a second aim – to promote fair and safe trade between countries. To be sure trade is fair, the

IPPC provides us with principles by which the rules of trade are established, while ensuring also that this trade is safe, that it does not put in jeopardy the health and productivity of plants in the importing country.

The third aim, that of protecting plant life, is supported by the first two, and ensures that countries have the tools and skills they require to protect themselves from pests that may be inadvertently introduced when people trade in plants and plant products.

Slide 11



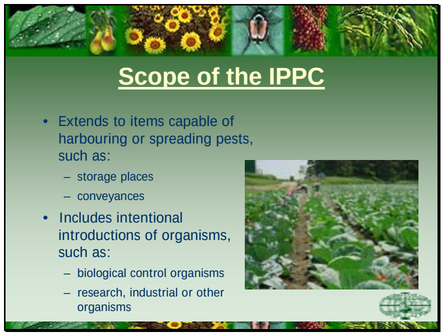
Points:

Historically the IPPC was limited to only plants and plant pests. These plants included agricultural plants, forests, and wild flora, while pests included invertebrates, diseases, and weeds.

In fact, the IPPC addresses all types of host and the full range of pests which threaten them. An NPPO may apply the IPPC standards to protect agricultural plants or wild plants, and it may use these standards to prevent or respond to the entry and introduction of all kinds of pests, whether they cause direct or indirect effects on these plants.

Here we see an introduced Asian long-horned beetle and a street tree which has been killed by it. Measures to address Asian long-horned beetle will protect urban forests as well as commercial forests and prevent consequences which range from loss of the social or environmental values associated with urban shade trees, as well as the economic values associated with commercial maple forests.

Slide 12



You will remember that the first aim of the IPPC is to prevent the spread of plant pests; this includes spread not only in plants and plant products, but also spread by other means. IPPC measures may therefore be applied to other items – packing materials, planting materials, storage devises, or conveyances such as trucks, commercial shipping containers, or the holds of ships. An timely example of this is the recent international standard for solid wood packaging. ISPM 15 specifies measures to prevent the accidental introduction of pests in wooden packing materials used to transport all kinds of goods, from automobiles and household goods to construction materials and equipment.

Until now, we've spoken of measures to prevent the unintentional introduction of pests that may result from other activities. Sometimes, though, people wish to intentionally introduce organisms which may be pests, and this too may be addressed under the IPPC framework. Scientists, industrial companies, hobbyists, teachers, and many others seek to intentionally import living organisms, ranging from bacterial cultures for industrial applications, nematodes for biocontrol of other plant pests, butterflies or ants for school projects and every kind of living thing for research purposes. IPPC principles and measures may be addressed in all these cases to protect plant resources, if the NPPO so decides.

Slide 13

Note to speaker: These principles will come up and up again throughout the week because they are so fundamental to the IPPC. Though the standards are only guidelines and not rules which an NPPO must follow, the principles are not up for negotiation. By implementing the standards, however, an NPPO can be assured of being consistent with the principles. The standards to which this is most true are the PRA-related standards. It doesn't hurt to spend a little time on these principles and not just gloss over them for the sake of time.

Depending on time and the group in question. You may want to pause here a moment, or activate the animation of this slide, so that the bullets are not immediately displayed, and ask participants if they know the principles of the IPPC. Or you could show the whole slide and ask if anyone can explain any of these principles. Its an opportunity to introduce the interactive nature of the course early in the first day.

Points:

The IPPC has eight key principles. These are the fundamental building blocks of the IPPC and are critical to its successful application in any individual member country. While the standards are guidelines, the principles are not. Understanding and adhering to the principles of the IPPC are critically important to its implementation in member countries.

The first principle is that of sovereignty. Every country has the sovereign right to use phytosanitary measures to prevent the introduction of quarantine pests and to determine its own level of acceptable risk whether that be very high, very low or somewhere in the middle. The remaining principles relate to any phytosanitary measures that are applied.

Measures should only be applied when necessary to prevent the introduction or spread of quarantine pests, and/or when the impact of regulated non-quarantine pests warrants it. Where applied, measures should be consistent with the pest risk, technically justified, and the least restrictive to address the risk. Where possible measures shall be based on international standards, guidelines and recommendations developed within the framework of the IPPC.

Additionally, the entire process should be transparent. Requirements, restrictions, prohibitions, and rationale for these measures and any modifications made to them, should be published and available upon request. The final key principle is that of dispute settlement. Disputes should be resolved where possible at the technical bilateral level.

We'll here more about these principles this week as we discuss PRA in greater and greater detail, since implementing PRA in an NPPO is one of the most significant ways that a member country can ensure that it has respected the principles of the IPPC in the establishment of its phytosanitary measures and regulations.

Slide 14

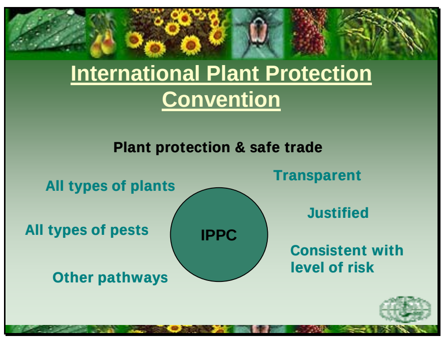
Note to speaker: On this slide there the speaker has a chance to tell participants that he/she works for his/her country's NPPO and tell them the name of that organization. It would also be good to be certain of the name of the NPPO of the country in which the course is being held, or possibly the NPPOs of other participants in the room. This is also an opportunity to involve the audience and to make the course personal by asking them the name of their NPPO(s). Not all participants will necessarily work directly for the NPPO of the host country.

Points:

While the IPPC confers rights on a member country, the right to establish its own level of protection for example, it also confers obligations. Contracting parties of the IPPC are responsible for meeting these obligations in the manner most appropriate to its circumstances. These obligations include the creation and administration of a National Plant Protection Organization, or NPPO, and the designation of an official IPPC contact point.

Once created, the NPPO is also responsible for conducting treatments, certifying exports and regulating imports. As contracting parties to the IPPC, NPPOs are obligated to participate in international cooperation, including sharing of information of pests and regulations and notifying trading partners when imported goods do not meet your import requirements.

Slide 15



Note to speaker: this is wrap-up slide about the IPPC. It summarizes everything that has been said so far about the IPPC because you are about to talk about the WTO next and condensing the IPPC information into a single slide helps to keep that information separate from the WTO information. It wraps up the context for doing PRA and is another good moment for a pause and questions about the IPPC, if there are any.

Points:

In summary, then, the IPPC is an international agreement which aims to protect plants and to promote fair and safe international trade. It can be applied to all types of plants – including agricultural plants, forestry species, and naturally occurring plants in all kinds of habitats. And it covers all types of pests and all types of pathways by which they might move. Membership in the IPPC confers on a country both rights and obligations. Provided the principles of the IPPC are respected, an NPPO has the sovereign right to determine when phytosanitary measures are applicable. Included in these principles are three that are particularly pertinent to PRA – namely, transparency, justification for measures, and consistency of measures with the level of risk they address. We will see this week, that implementing PRA as a decision-making process in an NPPO helps a country to respect these principles.

Slide 16

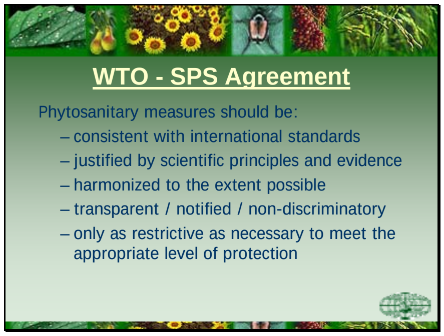
Note to speaker: Remember that the next few slides may not be particularly pertinent if the host country, or the countries for which participants come to the workshop, are not members of the WTO. Nonetheless, it may be worth mentioning the WTO since the two agreements are so complimentary and since so many countries are members of both. Even if the participants are not a member of the WTO, many of their trading partners are very likely to be and so the information will be indirectly applicable to them also.

Notes:

The second major international agreement that I will mention at this point is the World Trade Organization. This is the global agreement governing international trade in all products which establishes the rules by which nations conduct trade. The Sanitary and Phytosanitary Agreement of the WTO outlines the requirements for international trade as it pertains to plant and animal health.

To ensure that international trade does not put plant health in jeopardy, the WTO acknowledges the importance of the work of the IPPC; the IPPC is therefore recognized as the international standard-setting body under the WTO-SPS for matters pertaining to plant health. In this way, the International Standards for Phytosanitary Measures, the ISPMs, are recognized under the WTO.

Slide 17



Points:

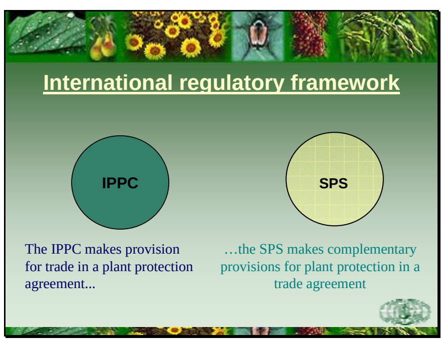
By looking more closely at the WTO-SPS requirements for phytosanitary measures, you will see great consistency with the principles of the IPPC.

Consistent with international standards refers to the ISPMs of the IPPC. As we go through the week, we will become more and more familiar with those standards, and particularly the ones that relate most directly to PRA

Justified by scientific principles and evidence – again, full agreement with the IPPC and again, evidence of the importance of PRA as a means by which to ensure that measures are justified and based on scientific evidence

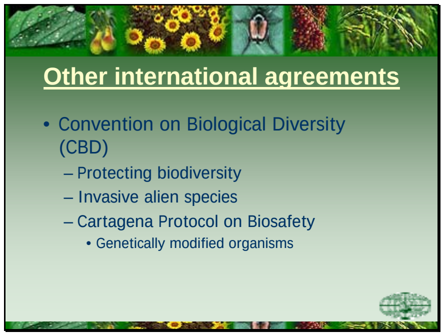
Harmonized, transparent, non-discriminatory and only as restrictive as necessary to achieve the appropriate level of protection – again, these are all principles which reflect the principles of the IPPC

Slide 18



Note to speaker: Just a brief wrap-up to demonstrate how the IPPC and the WTO-SPS Agreement are complementary agreements which seek to achieve the same ends from different directions. They are mirror images of each other in many ways.

Slide 19



Note to speaker: the CBD and Cartagena Protocol are mentioned only in passing and by way for setting the international context in which the IPPC sits. No further discussion occurs within this course and no significant questions or issues are anticipated to be raised. The student's manual provides slightly more information and the CBD web-site is very comprehensive.

It might be worth knowing if any participants or if the hosts are representatives of countries that are members of the CBD, or if there are any high profile biodiversity issues in the host country that are also plant protection issues which can be used here to illustrate the overlap.

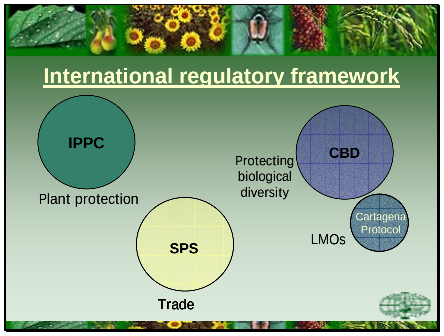
Points:

A third, and more recent, international agreement which enters into discussions of the movement of plants and other species between countries is the Convention on Biological Diversity or the CBD

That agreement recognizes invasive alien species as a major threat to biodiversity in the world, second only to habitat destruction. Invasive alien species are those species which, when introduced to a new area, are able to become established and cause harm to native species in that area. You can see, therefore, that invasive alien species and quarantine pests have much in common. The IPPC and the CBD recognize this common ground and seek to find ways to cooperate while addressing concerns regarding the introduction of species from one area to another where consequences may not be beneficial. Invasive plants or weeds represent an area of significant area of mutual concern between the CBD and the IPPC.

A second component to the CBD is the Cartagena Protocol on Biosafety, an agreement on the use of genetically modified organisms, again some of which may be plants or plant pests, and which may then overlap with IPPC concerns.

Slide 20



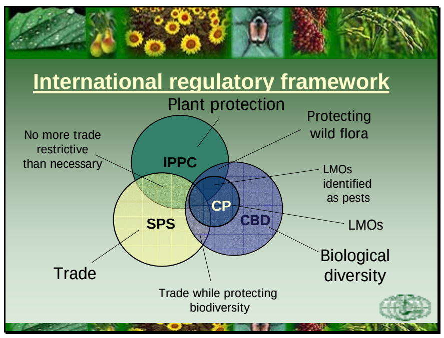
Very quick slide to remind participants of the 4 agreements that have been presented to them.

Points:

Those of us concerned with the protection of plants from biological threats or pests are working in a complex international environment

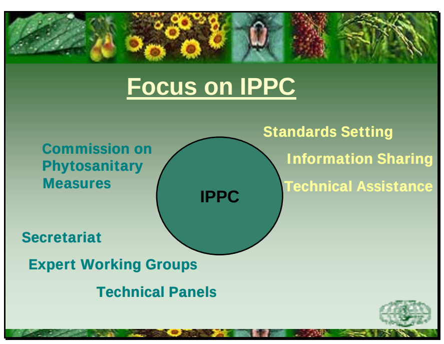
These conventions provide support and structure to the work that we do and by working within this framework we are better able to achieve agreement and success between nations.

Slide 21



Note to speaker: Again, a very quick slide, simply demonstrating the overlaps and distinctions between the four agreements presented earlier.

Slide 22



Note to speaker: bring focus of group back to IPPC

Points:

Protecting plants from introduced pests and promoting safe trade in this complex international arena, and in a world where people, commodities and conveyances are moving between countries continuously is a challenging task. How does the IPPC do it, and how do individual nations contribute?

For those of us who conduct PRAs, it is helpful to understand how the IPPC works, what it does and how we can contribute on the international front.

The business of the IPPC is managed by the Commission on Phytosanitary

Measures, or the CPM. This is governing body of the IPPC and each NPPO may send representatives to sit on the CPM and to help direct its work. IPPC work falls into three general categories :

standards setting: we have heard that the WTO recognizes the IPPC as the standard setting body for plant health matters; this week our focus will be on the specific standards that relate to PRA but we will refer often to other standards, such as the glossary of terms, as no standard is completely independent of the others (remind participants that they have received copies of the standards as part of their course materials)

information sharing: one of the principles of the IPPC, you will remember, is transparency; the IPPC maintains a web-site and assists countries to share information on their pest status, their plant quarantine pests, and their phytosanitary regulations

technical assistance: the IPPC also provides technical assistance to countries who are struggling to implement the IPPC in their countries; this training course is an example of IPPC technical assistance, but other ways in which they provide assistance is through the development of standards and explanatory documents.

-- technical work such as development of standards or training materials is undertaken by Expert Working Groups or Technical Panels
-- day-to-day management, communication, co-ordination & information sharing is handled by the small IPPC Secretariat in Rome

Slide 23

How many countries sit on CPM?

Essentially, CPM members are the contracting parties themselves (i.e. countries or governments). Contracting parties send representatives to the meeting, and the individuals and numbers of people sent often changes from
year to year. There is no obligation to send anyone to the meeting, so the
size of delegations can range anywhere from 0 to 15 (if you're China). The participants list is in the back of last year's CPM report

Commission on Phytosanitary Measures
Governing body of the IPPC
Membership contracting parties only
Observers from countries that are not contracting parties, Regional Plant Protection Organizations and international organizations
Receives input and suggestions from NPPOs

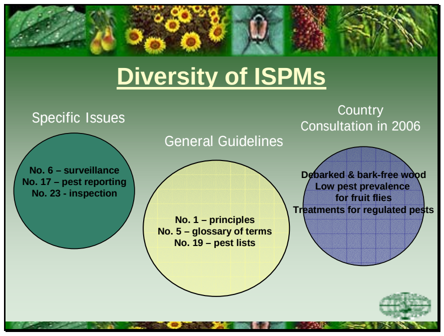
Slide 24

ISPMs are created to act as guidelines to help establish and maintain harmonization of phytosanitary measures used in international trade.

Voluntary

serve to harmonize phytosanitary measures used in international trade

Slide 25



Note to speaker: this is just a very quick overview to demonstrate the diversity of standards available and the fact that more are being developed or proposed for development all the time; it might be a nice touch to confirm that the host country sends one or more delegates to CPM and if they have a representative on the Standards Committee. If so, mention it during that point in the explanation, again as a way of keeping the course personal.

Points:

IPPC standards are referred to as ISPMs, standing for International Standards for Phytosanitary Measures. As of January 2007, there were 27 approved standards but more are approved by CPM each year and others are proposed for development or underway. In general, standards fall into two categories, highly specific pest-oriented or activity-oriented standards such as that for pest reporting or inspection etc., and those of a more broad nature, such as the standards on principles, the glossary of terms or the standard for developing pest lists

(If there is interest, you can explain how new standards come to be, if not, just skip the following....)

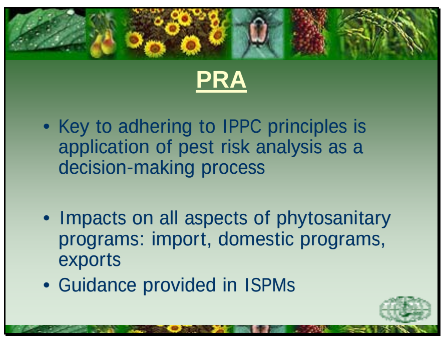
For a standard to be developed, a need must be recognized either by the IPPC or by a member country, and the standard proposed to CPM by a country representative. The CPM (remember it's made up of member country representatives) discusses the proposal and if there is considerable interest and agreement that the proposal is a good one, then it is considered as part of the IPPC work plan and referred to the Standards Committee of CPM. The Standards Committee drafts an assignment, an expert working group is formed and the task is passed to them. When a draft has been prepared to the CPM's satisfaction, it is submitted to a country consultation period during which all member countries have an opportunity to provide input, a final draft is prepared and a new standard is approved.

(Depending on the group, you may want to ask the following questions in order to involve participants more actively....)

Ask what standards participants are familiar with?

What would you like to see a standard for?

Slide 26



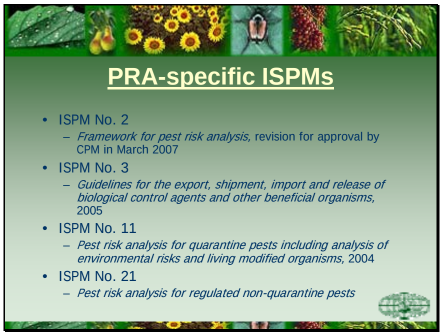
Points:

So what has all this to do with PRA and when do we start the training course? This background information has everything to do with PRA because the easiest way for an NPPO to ensure that it is living up to the principles of the IPPC is to adopt PRA as a key part of its decision-making process when it comes to establishing phytosanitary measures and regulations for plants and plant products

PRA impacts on all aspects of a nation's plant protection or plant quarantine program – import, export or domestic – because it provides you with the information you need to determine the most appropriate course of action in a given situation.

The guidance for PRA is provided in several distinct ISPMs.

Slide 27

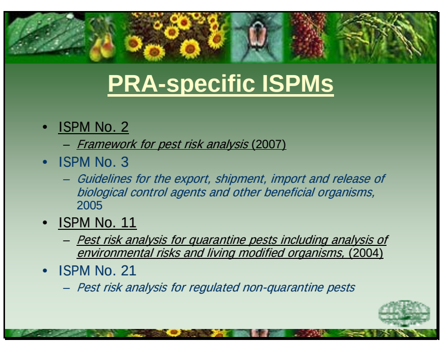


There are many ISPMs that are either directly pertinent to PRA, such as these listed here, or are indirectly important, such as the glossary of terms, number 5, or the guidelines for lists of pests, number 19.

ISPM 2 – describes the process of PRA for plant pests
ISPM 11 – provides details for conducting PRA on quarantine pests
ISPM 21 – provides details for conducting PRA on non-quarantine pests

ISPM No. 1 (*Phytosanitary principles for the protection of plants and the application of phytosanitary measures in international trade,* 2006)
ISPM No. 5 (*Glossary of phytosanitary terms*, 2006)
ISPM No. 6 (*Guidelines for surveillance*)
ISPM No. 8 (*Determination of pest status in an area*)
ISPM No. 14 (*The use of integrated measures in a systems approach for pest risk management*)
ISPM No. 17 (*Pest reporting*)
ISPM No. 19 (*Guidelines on lists of regulated pests*)
ISPM No. 24 (*Guidelines for the determination and recognition of equivalence of phytosanitary measures*)

Slide 28



We will concern ourselves primarily with two of them this week, ISPM Number 2 which gives us the overall framework for pest risk analysis, and ISPM number 11 which provides us with considerable more detailed guidance for pest risk assessment, in particular.

Slide 29

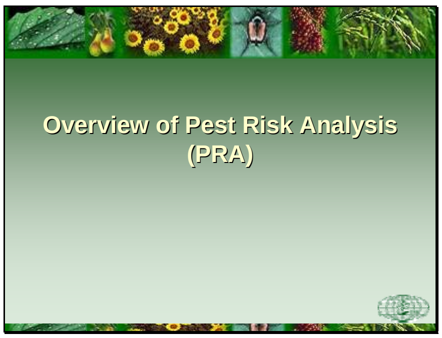
Note to speaker: this is just a wrap-up slide reminding them of the key points ... it is animated so each bullet shows up one at a time.

Overview of PRA

Slide 1

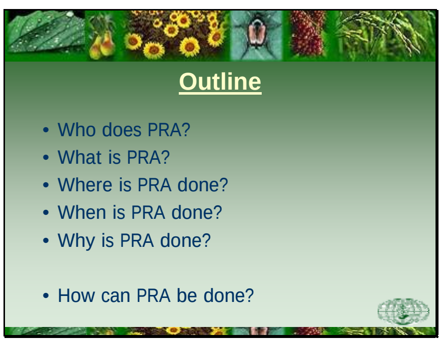
Greet participants. We are here today to discuss and explore the concept and process of pest risk analysis.

Slide 2



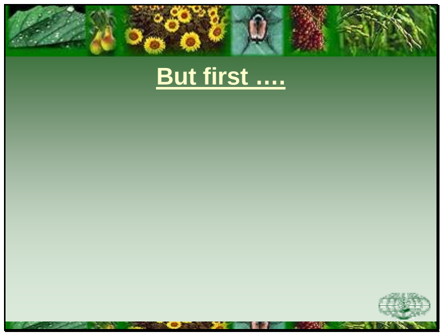
Let'sl begin with the overview of pest risk analysis.

Slide 3



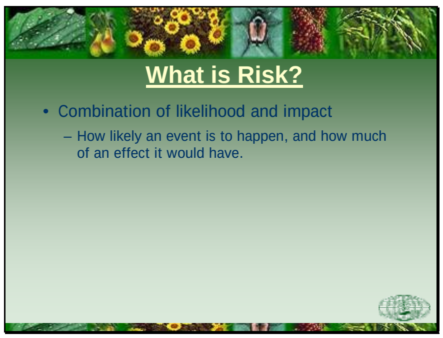
I'm going to talk about the who, what, where, when, why and how of PRA. Who does PRA? What is PRA? Where is PRA done? When is PRA done? Why is PRA done? And how is PRA done? The first five bullet points can really be explained quite quickly, maybe in half an hour but the 'how can a PRA be done' is the nub of this course. That is what we are going to spend the next week learning.

Slide 4



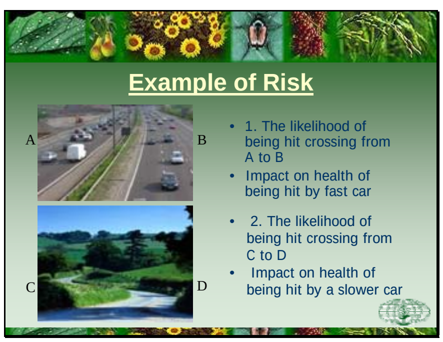
But first…

Slide 5



…what is risk. Risk is a combination of likelihood and impact. That is how it is generally considered - How likely an event is to happen and how much of an effect it would have.

Slide 6

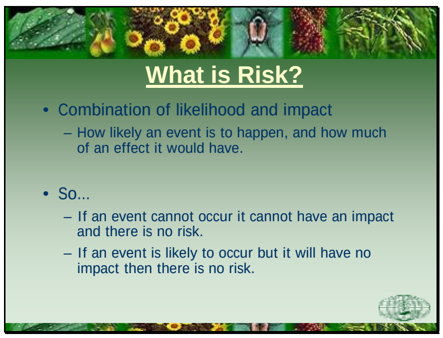


As an example, let's consider crossing the road here from A to B. This is a motorway in Britain with lots of traffic moving very fast in straight lines up and down. The likelihood of a pedestrian being hit crossing the road from A to B, would be quite high. There is a lot of traffic moving very fast so that if the pedestrian were to be hit, the impact on their health would be serious – either resulting in serious injury or death.

In contrast, if we consider crossing this road from C to D – a narrow country lane with winding bends and little to no traffic. Here, the likelihood of a pedestrian being hit crossing the road from C to D would be quite low. The impact on their health, if they were to be hit, is also low because the cars are moving much slower around the bends.

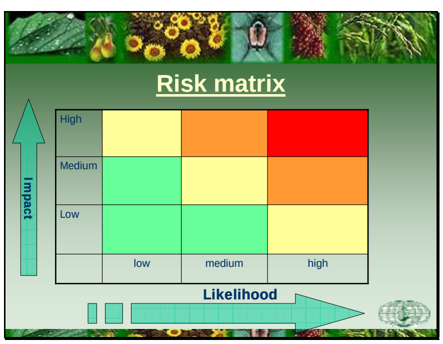
The risks associated with crossing the road from A to B and C to D are quite different though they are both the process of crossing the road.

Slide 7



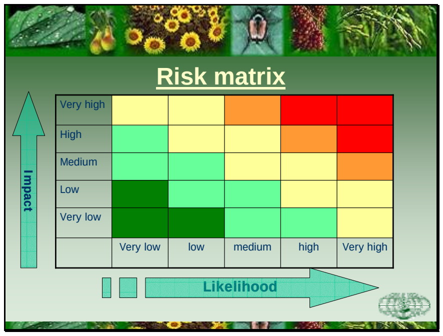
What is risk? As was mentioned before it is a combination of likelihood and impact. How likely is an event to occur and how much of an impact will it have? So, if an event cannot occur, it cannot have an impact so there is no risk. If an event can occur but has no impact there is also no risk.

Slide 8



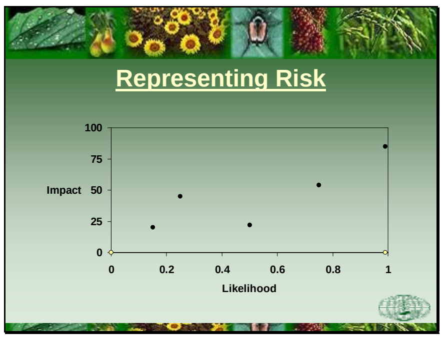
This matrix is quite a common method of how risk is presented. Likelihood is along the x-axis and impact on the y-axis. There are different colours: red, orange, yellow, and green to represent different combinations of likelihood and impact. The red with high likelihood and high impact is a sort of danger zone. Green is low to medium likelihood with low to medium impact and the yellow and orange are intermediate stages.

Slide 9



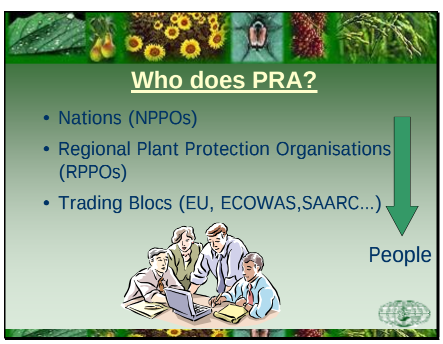
Here we have very low, low, medium, high, very high for both likelihood and impact, so we have five levels and have increased the numbers of intermediate stages.

Slide 10



You could represent risk quantitatively perhaps – as a probability between 0 and 1 on the x-axis and perhaps financial impacts on the y-axis. Risk is now represented as dots on the chart rather than squares on the grid. Note on the x-axis on the extreme right the dot on the bottom. An event that is almost certain to occur but with no impact – therefore no risk. Equally, the other dot at the bottom left, the origin, where there is no impact and no likelihood so again no risk.

Slide 11

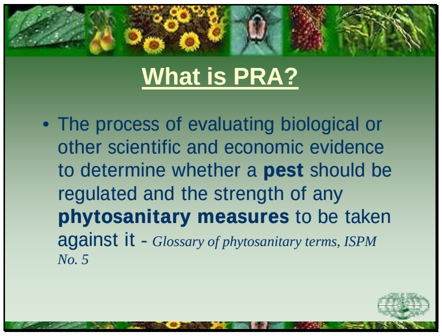


Who does PRA? Nations, that is NPPOs, National Plant Protection Organizations, conduct PRA. RPPOs, Regional Plant Protection Organizations, and trading blocks can also conduct PRA. Ultimately however, it is individuals like you completing the PRA for organizations such as the ones listed here.

EU = European Union

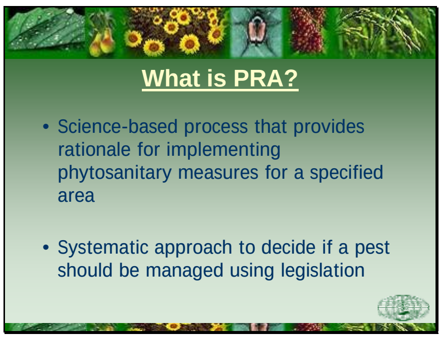
ECOWAS = Economic Community of West African States
SAARC = South Asian Association for Regional Co-operation

Slide 12



What is pest risk analysis? Using the ISPM glossary definition: it is a "process for evaluating biological or other scientific and economic evidence to determine whether a pest should be regulated and the strength of any phytosanitary measures to be taken against it". The terms pest and phytosanitary measures also have specific definitions in the ISPM glossary (ISPM No. 5).

Slide 13

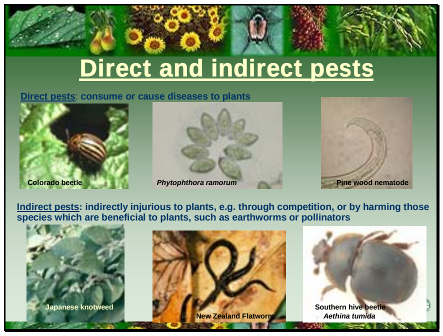


Another way of thinking of what is pest risk analysis is that it is a science- based process that provides a rationale for implementing phytosanitary measures for a specified area. Or you could think of it as a systematic approach to decide if a pest should be managed using legislation.

Slide 14

What is a plant pest? Well, again as mentioned before this is defined in ISPM No. 5. A pest is "any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or plant products". It is possible to think of it as any organism harmful to plants. That includes fungi, bacteria, ticks, mites, insects, other plants, nematodes, and viruses for example. The IPPC recognizes direct and indirect plant pests.

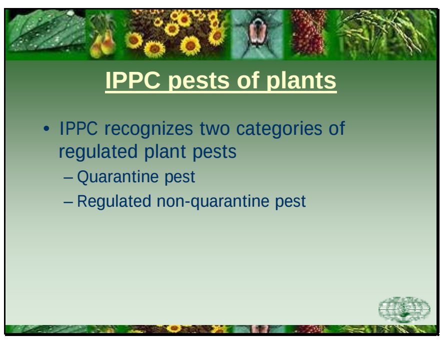
Slide 15



Direct pests consume or cause disease to plants. Some examples here are Colorado beetle, *Phytophthora ramorum*, and Pinewood nematode.

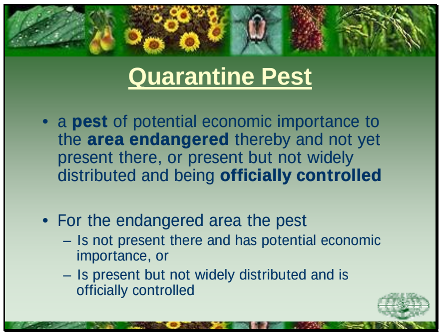
Indirect pests are indirectly injurious to plants perhaps through competition, or by harming species which are beneficial to plants such as pollinators or earthworms. Japanese knotweed is an invasive plant that out-competes other plant species-so it is an indirect pest. New Zealand flatworms, a predator of earthworms, can reduce the population of earthworms in the soil and thus reduce the amount of aeration that the soil receives. The southern hive beetle is a vector of disease of honeybees. Honeybees are very important in pollinating crops and thus reductions in number reduces the amount of pollination occurring and can have effects on orchards for example.

Slide 16



IPPC recognizes two categories of regulated plant pests: quarantine pests and regulated non-quarantine pests.

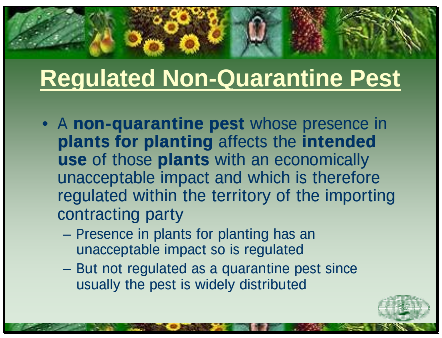
Slide 17



A quarantine pest is a pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled.

So for the endangered area the pest is not present there but has potential economic importance or is present but not widely distributed and is officially controlled.

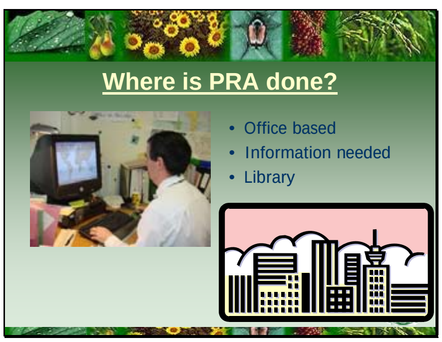
Slide 18



A regulated non-quarantine pest (RNQPs) is something whose presence in plants for planting affects the intended use of those plants with an economically unacceptable impact and which is therefore regulated within the territory of the importing contracting party. The important point here is the presence in plants for planting and has an unacceptable impact which is why it is regulated. These are not regulated as a quarantine pest because usually the pests are widely distributed.

This course will not focus on RNQPs

Slide 19

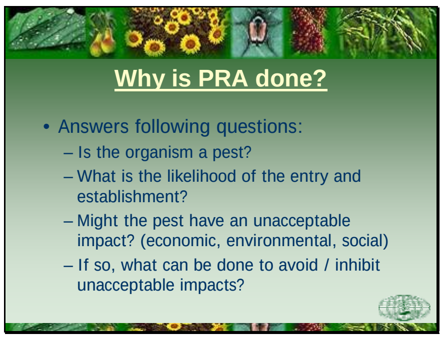


Where is PRA done? Well, it is normally office-based. You need a lot of information and possibly access to a library. Being based in an office environment often provides you with the resources you need.

Slide 20

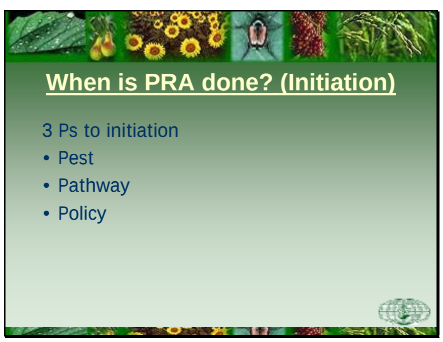
Why is PRA done? It is done to evaluate and manage risk from specific pests and internationally traded commodities. PRA identifiess and assesses risks to agricultural and horticultural crops, forestry and the environment from plant pests. PRA is used to create lists of regulated pests, produce lists of prohibited plants and plant products and to assist in identifying appropriate management options.

Slide 21



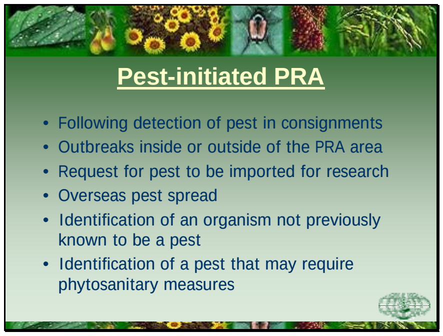
PRA also answers questions. The PRA process can help decide whether or not an organism is a pest and determine what is the likelihood of the entry and establishment of the pest. It also helps determine if the pest might have an unacceptable impact, with impacts being economic, environmental or social. If so, if it is a pest and does have an impact – the PRA can help identify what can be done to avoid or inhibit unacceptable impacts.

Slide 22



When is PRA done? What initiates a PRA?
There are three Ps to initiation: Pest, Pathway, Policy.

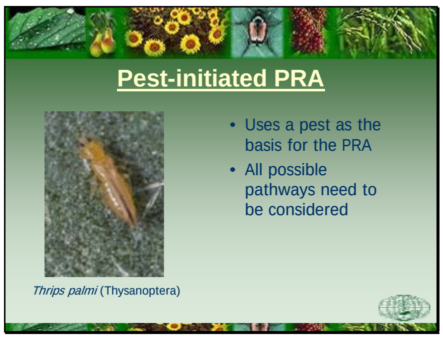
Slide 23



Pest-initiated PRA...

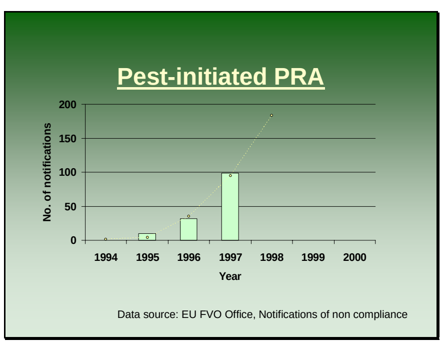
These PRAs could be initiated following the detection of a pest in a consignment during import inspections, or because of outbreaks in or outside the PRA area. Perhaps at a university someone wants to import the pests for academic research or perhaps there are reports of the pest spreading overseas. Another possible initiator of PRA is an organism that was not previously determined to be a pest and has been discovered to be a pest. Basically all of the above are where a pest is identified and it may require phytosanitary measures.

Slide 24



There are two approaches to PRA...the pest approach uses a pest as the basis for the PRA and then all the different pathways for a pest entering are considered. An example of a pest that has initiated PRAs is *Thrips palmi*.

Slide 25



The European Union collects data on the number of detections on consignments and an analysis showed that previous to 1994 *Thrips palmi* probably hadn't been intercepted in the EU. In 1995 it began to be intercepted and was increasing in 1996 and 1997.

If that had continued you would expect even more interceptions if following the trend as the yellow line indicates on this slide.

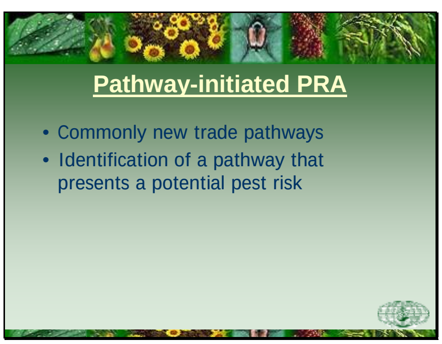
Slide 26

In 1997 an analysis was completed and it showed that most of the *Thrips palmi* interceptions were principally originating in Southeast Asia – specifically Thailand on orchids – but also from the Caribbean and Africa.

Slide 27

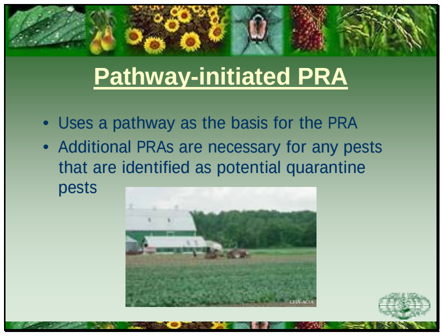
A PRA was carried out and during the risk management phase the EU consulted with the Thai ministry of agriculture and basically came up with some mitigation measures. Thai orchids were required to be produced at a site certified free from *Thrips palmi*, or if it couldn't be certified by the Thai government to be free from the pest an appropriate treatment such as fumigation can be applied. This allowed trade to continue. Measures were monitored and the number of interceptions of *Thrips palmi* on Thai orchids decreased after the implementation of measures in February 1998.

Slide 28



Pathways are another way of initiating a PRA, for example when new trade pathways are about to open up or are requested. A new pathway might present a new risk.

Slide 29

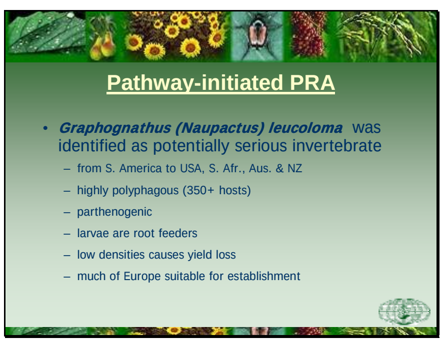


Instead of an individual organism or individual pest, the focus of the PRA here is the pathway which might carry a number of pests. Basically, a pathway approach combines a number of individual pest PRAs together for looking at a single pathway or host commodity.

Slide 30

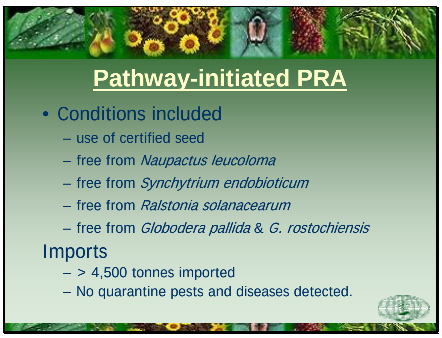
For example, potatoes from New Zealand. This PRA was initiated because New Zealand requested that they sell ware potatoes into the EU. At the time such trade was prohibited, but information was gathered from books, journals, literature searches, electronic sources, CABI CPC, and the Internet among others.

Slide 31



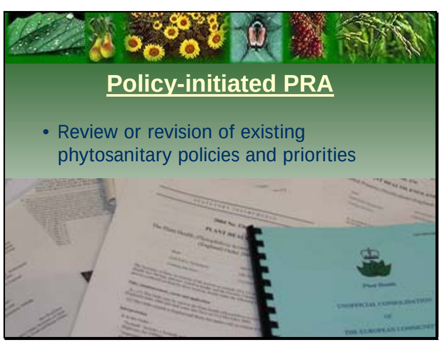
Graphognathus (Naupactus) leucoloma, called the white fringed weevil, was identified as one of the potentially serious pests. *Graphognathus (Naupactus) leucoloma*, has a history of spreading internationally. It is native to South America but in the first half of the 20th century spread to the USA, South Africa, Australia and New Zealand. It feeds on many hundreds of plants with crops such as carrots, potatoes, peas and other legumes, strawberries and maize at risk in the EU. It reproduces asexually so lone females that enter a new geographic region can establish a new population. Larvae cause the most serious damage since they are root feeders but adults also cause damage when they feed on leaves. Even low densities of larvae can cause economic damage. Given the pest's distribution and comparison of the climates of Europe and New Zealand, much of Europe appears appropriate for establishment. All this type of information was included in an individual UK summary PRA for this pest, and with 14 other such PRAs sent to PHSC and discussed.

Slide 32



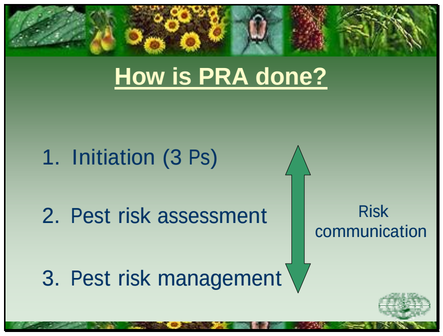
As a consequence of the PRA, risk management measures were set up and which included the use of certified seed and measures to ensure freedom from identified pests. Where the potatoes came from had to be certified free from *Naupactus leucoloma*, and the diseases and nematodes listed here as well. Since these risk management measures have been in place, over four and a half thousand tonnes of potatoes have been imported from New Zealand and no quarantine pests or diseases have been detected.

Slide 33



Another way of initiating PRA is through policy reviews, reviewing legislation for example.

Slide 34



Now how is PRA done? There are three stages. The first is initiation and remember the three Ps (pest, pathway and policy). Then there is pest risk assessment and finally there is pest risk management. Risk communication is an ongoing process throughout all of these stages.

Slide 35

This again is a three step process with...
The categorization of individual pests
Then the assessment of the probability of introduction and spread
And finally the assessment of the potential economic consequences of the introduction and spread

Slide 36

The pest risk management stage is defined as “the evaluation and selection of options to reduce the risk of introduction and spread of a pest”.

To achieve an appropriate level of protection, governments must balance measures to counter assessed risk, against obligations to minimise negative trade effects so PRA aims to ensure the decisions will be well-informed, transparent and neutral.

Slide 37

Communication was mentioned earlier. Risk communication should not be regarded as a discrete stage of PRA. It is continuous throughout the PRA process. It ensures that the views of all parties is taken into consideration when making decisions and if information is shared, government and stakeholders will often reach the same conclusions. It also helps ensure international harmonization.

The purpose of risk communication is to reconcile the views of scientists, stakeholders, politicians, and others in order to...

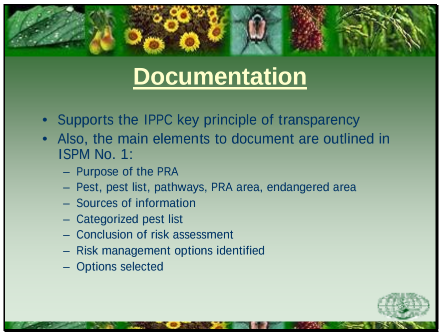
Achieve a common understanding of the pest risks

To develop credible pest risk management options

To develop credible and consistent regulations and policies to deal with pest risks

And to promote awareness of the phytosanitary issues under consideration

Slide 38



An important part of PRA is documentation which also helps to maintain transparency. Transparency is one of the key principles of the IPPC.

The main elements that should be documented are outlined in ISPM No. 1 and they are:

The purpose of the PRA

What the pest is, lists of pests if it is associated with a commodity, pathways, identifying a PRA area, the endangered area within the PRA area

Where the information comes from

Categorized pest lists

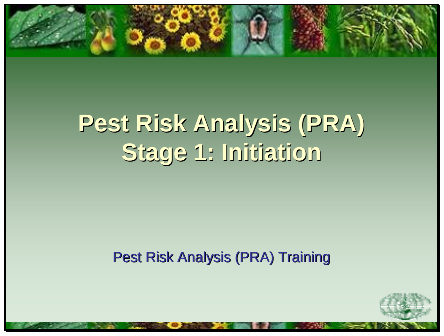
Conclusions of risk assessment

The identified risk management options

And finally identifying which risk management options may be selected

Initiation

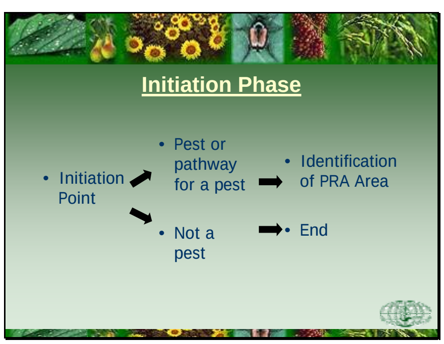
Slide 1



Slide 2

This talk is the first talk to describe a specific part of the PRA process. Our preceding talks gave an overview of the whole process, now we are going to focus on the first step – initiation.

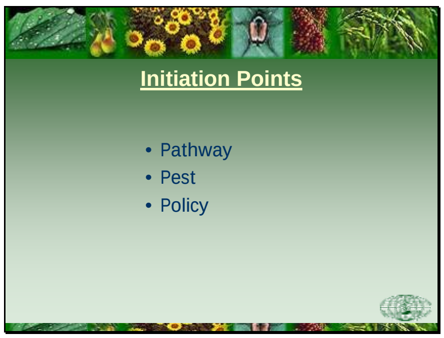
Slide 3



Greatly simplified, the initiation phase looks like this. An organism or an issue arises which may be an initiation point for a PRA. The first step is to determine if it is relevant to the IPPC and should be addressed by the NPPO. In order for it to be an IPPC issue, the organism must fit the broad IPPC definition of a pest or potentially be a pathway for species that are pests. If so, the PRA continues, and if not, the PRA ends.

This step is not an elaborate evaluation of how much, if any, damage the species could cause, but simply a screening to eliminate things that are not IPPC issues, for example animal parasites or pathogens or pathways for human disease may be reported in scientific journals or other media and be brought to the attention of an NPPO. In subsequent steps, we will determine the seriousness or significance of the pest or pathway, and consider if measures should be taken against it.

Slide 4



An easy way to remember the initiation points which may result in a PRA is to remember the "three P's" – pathway, pest and policy. Although these are very diverse reasons to begin a PRA, once it is started, a single PRA process can be followed. We'll look at each of these types of initiation points and consider examples of each.

Slide 5

Note to presenter: there may be some confusion between pathway and commodity. Try to be clear and take questions, or perhaps ask people to give you examples of pathways or commodities to see if they recognize that pathway is a much broader term and encompasses not only commodities but other things as well. Ask them to provide you with examples of pathways in their country.

Points:
A common initiation point is a pathway. Pathways can take many forms – they may be commodities, or materials associated with commodities, or they may be conveyances, means of transporting things or people. They may be relatively simple or very complex.

Here we have fresh citrus fruits on the twig, complete with leaves, twigs, buds and fruits. Also pictured are spruce logs with bark intact and possible soil or plant debris attached, and thirdly potted Poinsettia in a growing medium. Each of these is a complex environment which could harbour pests and be a pathway for their distribution.

There is a fourth pathway pictured on this slide – the tractor. Used equipment, such as logging or farming equipment, and fire fighting or road building equipment may be an overlooked pathway for transportation of plant pests.

Slide 6

A pathway, therefore, may be any number of things. The first thing we think of when we think of pathways is a commodity, but in reality, a commodity is a sub-category of pathway. While a pathway is “any means that allow the entry or spread of a pest”, a commodity is “a plant or plant product being moved for trade or other purposes”. In our previous slide, then, the logs were the commodity, but both the logs and the tractor could have been a pathway.

In the picture here, we see a commodity – fresh Edelweiss blossoms -- that are clearly a pathway for spread as we can see a snail in the corner of the box which has crawled out of the bundle of foliage during transport and is trapped in the box. When a commodity is the initiation point for the PRA, the NPPO should consider any associated materials, such as packing or shipping requirements, that together will comprise the pathway.

Slide 7

A pathway may also be a means of transportation or storage, regardless of the commodity with which it is associated. Here we have containers waiting on a dock for shipping and a bin of dried peas. While the peas are a commodity, the ship and the bins may be pathways for spread of pests also. And the containers may be full of household goods or industrial equipment and still be a pathway for spread of plant pests.

Slide 8

Likewise, articles associated directly with the commodity may be a pathway for spread of plant pests. In the top picture, ginger roots imported for consumption are coated in soil which may harbour plant pests, perhaps pests of ginger, or perhaps pests of another kind.

And wooden pallets may likewise transport live pests from area to area, while the intended commodity may be refrigerators or other manufactured goods which present no risk to plant health whatsoever. We are all sensitized to the issue of solid wood packaging materials and the ISPM number 15 which provides guidance for managing pests moving on this pathway.

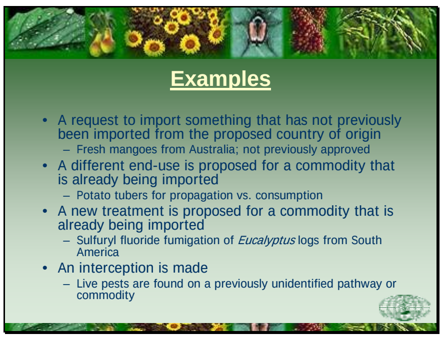
Other examples of pathways in this category would include the growing medium used for live plants, or perhaps the peat or other materials used to transport fragile goods or live plants.

Can you name any others? (e.g., wood substrate for epiphytic plants and orchids)

Slide 9

A natural means of spread may also be a pathway, as some species are naturally much more mobile than others.
While not readily addressed by phytosanitary measures, natural means of spread may be an important pathway for entry of the pest, and a critical factor to consider when we get to the pest risk assessment and must assess introduction and spread potential of the species, or the potential consequences of its occurrence in the PRA area.

Slide 10



Note to presenter: this is a very full slide. You are not meant to read the whole thing out but to paraphrase it briefly to demonstrate the variety of reasons a pathway might come to the attention of an NPPO and therefore be an initiation point for a PRA. The slide is animated so one bullet point shows up at a time.

Slide 11

Note to presenter: we are returning here to the “three P’s”, having covered pathway quite extensively; participants may have lost sight of the other two P’s and forgotten that we have still to cover them.

Points:

A pathway is not the only initiation point for a PRA. A specific pest may be brought to the attention of the NPPO and become the initiation point for the PRA. Here we have a grapevine infected with an unknown plant virus and swede midge a European insect which feeds on *Brassica* species. Both illustrate situations in which a pest may be the initiation point for a PRA.

Slide 12

Note to presenter: this slide is best presented by providing personal examples of PRAs initiated for the reasons listed on the slide or by asking participants if they can provide examples after you've given a brief introduction. The image shows the symptoms of citrus greening or yellow dragon disease, a bacterial disease transmitted by insects.

Points:
Many situations may arise which result in a pest being an initiation point for a PRA. Information is not a static thing and new information about pests and pathways which may interest NPPOs arises all the time.

Pest interceptions, for instance, are strong evidence of a pest's association with a pathway. Interceptions on imported products entering your own courntry or another may cause you to consider doing a PRA to determine if measures should be taken, and if so, what measures.

New pest reports in a country from which you import goods may cause you concern. Likewise, reports of new hosts or increased levels of damage, not previously recorded for a pest of concern.

A pest for which you had no previous records in your own country may be discovered there and may be an initiation point for a PRA.

Other reasons:
a new pest is identified by scientists
there is a change in the status or incidence of a pest in the PRA area
an organism is identified as a vector for other an organism is genetically altered in a way that impacts its potential to be a plant pest

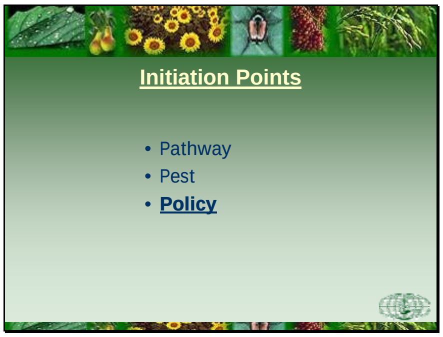
Slide 13

Note to presenter: Continuation of previous list of reasons for a pest being the cause for a PRA.

Slide 14

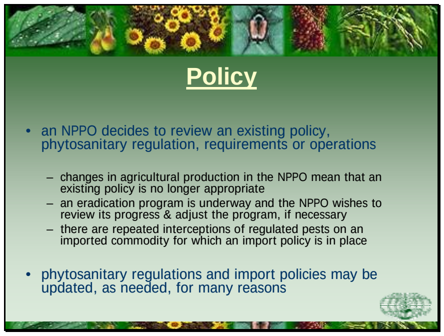
Note to presenter: this slide is a continuation of the list of reasons why a pest may be an initiation point. The important point to make here is that not all pest introductions are unintentional and that even a request to import a species may be a reason to do a PRA on that species. This is particularly, but not exclusively, pertinent to import requests for live plants, biocontrol agents or bio-remediation agents.

Slide 15



And the third initiation point -- Policy

Slide 16



Note to presenter: Again, a very busy slide, showing examples of different reasons that an NPPO may elect to initiate a PRA. You may wish to point out that in these cases, it is probable that the categorization step will be automatic, as it will have presumably been done at the time that the initial policy was developed.

This and the following slide are animated; bullets appear one at a time.

Points:

Other examples include:

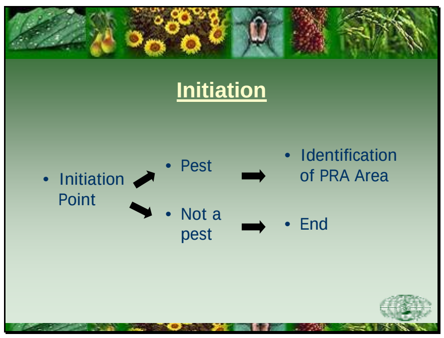
Brazil's review of its seed import program; introduced a requirement that all seeds entering country required a pest risk analysis; PRAs conducted on all imported seed from Canada
Canada's revised nursery stock policy, necessitated PRAs for commodities historically imported without a PRA

Changes in organizational structure, pest control methods or pest status, and production practices in an exporting country may result in a requirement to review import policies
Repeated interceptions, for example, an approved commodity may suggest that the situation has changed or was not as previously reported and necessitate an update to the PRA and adjustments to the policy

Solicit other examples from participants

Slide 17

Slide 18



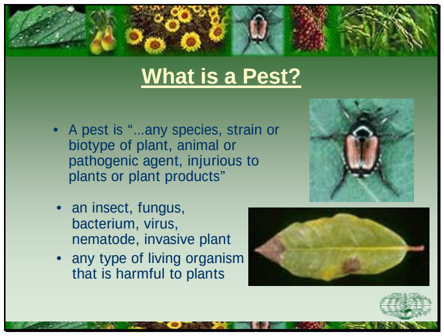
Note to presenter: Having described the three different types of initiation points, this slide is just a reminder that our next step is to categorize the pest/pathway as being a pest or not a pest, i.e., relevant to the IPPC or not.

Points:

We have covered the three P's that may be reasons to initiate a PRA, but we must also determine if indeed the issue is IPPC-relevant. Is the species that has been identified a pest by the IPPC definition, or is the pathway that has been identified a potential route of entry for a pest by that definition?

This process of determining that the the organism is a pest by that very broad definition is a very intuitive one and happens most naturally almost simultaneously with the identification of the issue by an NPPO. It is not meant to be a complex process nor to place a heavy demand on the NPPO for in depth research at this point. Elaboration of the point in the ISPM only clarifies the scope of things that may be covered under the IPPC and formalizes the process of ensuring that issues dealt with henceforth are appropriate for an NPPO under the IPPC.

Slide 19

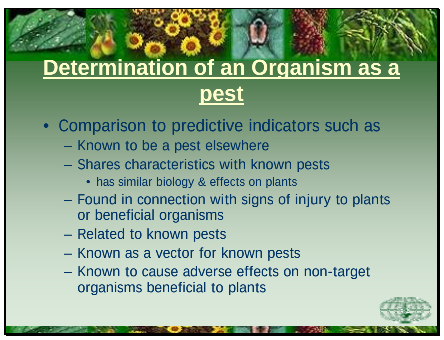


The Glossary of Terms, ISPM number 5, define a pest as "any species, strain or biotype of plant, animal or pathogenic agent, injurious to plants or plant products"

This is a very broad definition and includes all forms of organisms – insects, fungi, bacteria, viruses or virus-like organisms, nematodes, and even other plants, in short any type of living organism that could have a potential negative impact on plants, either direct or indirect

The definition excludes those organisms that could not have any impacts on plants, either direct or indirect, for example, animal diseases and human pathogens.

Slide 20



That definition is pretty broad and may include just about anything, so how do we decide then if an organism is a "pest"?

The categorization stage is not an in depth study of the organism, its simply a quick consideration of its characteristics to determine that it is a pest by that very broad, inclusive definition. Characteristics we might consider include:

Its characterization as a pest elsewhere – i.e., if a species is a plant pest elsewhere, chances are good that it will be in the PRA also; or that at least it will have potential to be a plant pest there

If it is related to known plant pests or its life history is very similar to that of a known plant pest, it should be considered to meet the categorization criteria and be a pest

Likewise, if it known to vector plant pests or be associated consistently with damage to plants, it meets the definition's requirements of a pest

Because the IPPC recognizes both direct and indirect damage, those organisms that may cause adverse effects on beneficial organisms, such as pollinators or bio-control agents, for example, may also be considered to be pests by the IPPC definition.

Slide 21

Organisms that are pests by the IPPC definition fall into the following general categories described in the standards...

Remember that the standards are guidelines only; these standards indicate that a PRA may be conducted for pests in these categories, though it does not say that they must be subjected to PRAs. Likewise, the categorization step has not given us any information yet about the significance of the pests nor the impacts they may cause and it does not provide any information on whether or not phytosanitary measures should be taken against it nor what type of measures are appropriate.

We do, however, now have enough information to be assured that a PRA is an appropriate next step and that the subject of the PRA is relevant to the IPPC.

For a pest-initiated PRA, it will be necessary to identify the pest that is the subject of the PRA.

Slide 22

For PRAs that result from the identification of a pathway, it is necessary to identify the pathway. It is not possible to do a PRA if the subject matter of that analysis is not clearly defined at the beginning of the exercise.

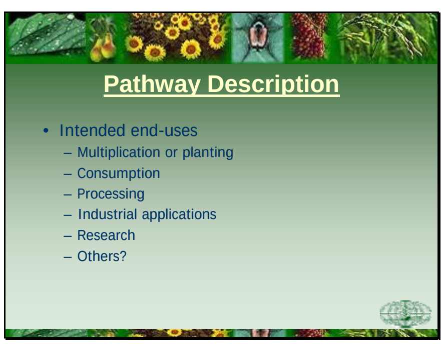
Here we have examples of two different pathways that might result in a PRA: Eucalyptus logs and fresh mangoes. For each, the NPPO may seek detailed information about the pathway from the exporting country's NPPO and the importer.

(Elaborate on questions displayed on slide for each pathway; seek suggestions for other questions that an NPPO might be interested in for these or other pathways.)

Slide 23

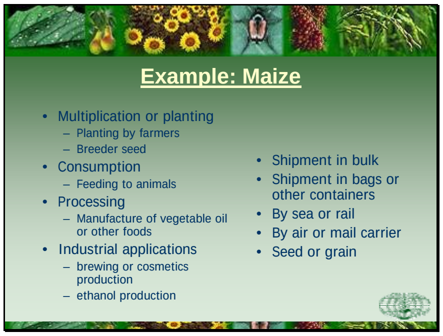
Many factors affect the likelihood that pests will be associated with a pathway and whether that association will result in pest entry or introduction. It is therefore very important, when beginning a pathway-initiated PRA, to know everything possible about the pathway, from its origins to its final destination. Where the pathway originates is obviously of great importance, but other factors such as production practices, for example, greatly influence the survival of any pests associated with the pathway and the exposure of any associated pests with suitable hosts in the PRA area.

Slide 24



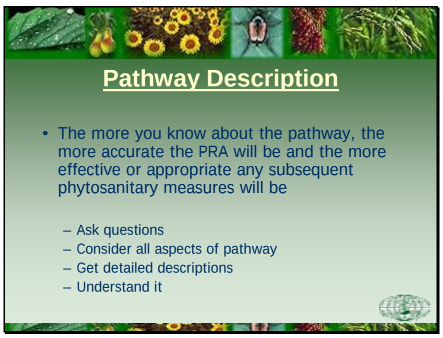
Likewise, intended end-use, for example, greatly influences the survival of any pests associated with the pathway and the exposure of any associated pests with suitable hosts in the PRA area.

Slide 25

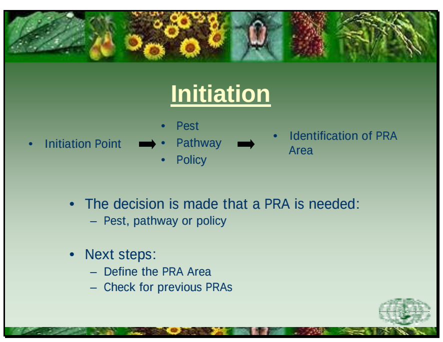


Take for example, a request to import *Zea mays*. This pathway may present very different pest risks depending on where it comes from, how it was produced, what its intended to be used for, and how it will be shipped.

Slide 26



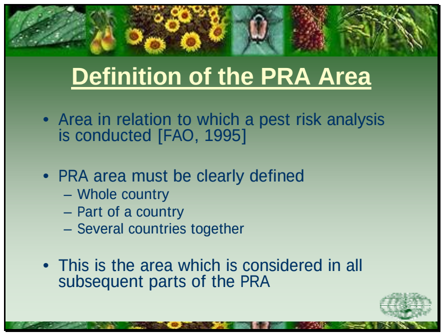
Slide 27



So, at this point, the initiation point for the PRA is known, the pest or pathway has been categorized and is known to meet the definition of a quarantine pest, and it has been determined that the PRA will continue.

The next step will be to define the PRA area.

Slide 28



Clearly defining the PRA area is a very important step because the PRA area is the area to which all subsequent steps in the PRA will refer. From the beginning of the PRA until its conclusion, the area that will be considered will remain constant – this is the area that is called the PRA area.

The official IPPC definition of PRA Area is “area in relation to which a pest risk analysis is conducted”. This means it’s the area which is discussed when determining a pest’s potential distribution, its entry potential, its potential hosts or future impacts. Defining the PRA very precisely is therefore very important.

The PRA Area is often a whole country, but there are many examples of when it might be either more than one country, or less than a whole country

-- Less than a whole country – Island nations might consider isolated islands individually, for example Phillippines, or Hawaii (part of US) or Channel Islands (part of UK) etc.

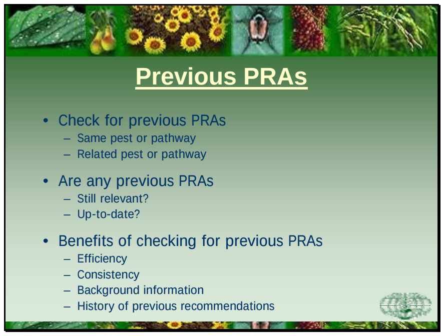
-- geographically small countries belonging to a single RPPO and with similar circumstances might contribute jointly to a PRA for a pest of mutual concern, for example, European PRAs on invasive plants, South or Central America

-- North American PRA on pitch canker conducted for Canada – US – Mexico

Stress importance of clearly defining area and then always referring back to that area throughout PRA – economic impacts in that area, potential distribution in the same area, effects of mitigation measures etc.

Does not have to be the area to which phytosanitary measures are ultimately applied, but it must be the area which is considered consistently throughout the PRA.

Slide 29

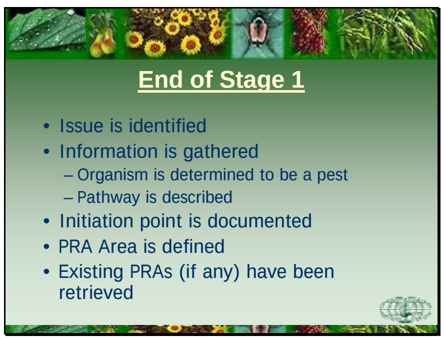


Checking for previous PRAs is just good common sense; it may save a lot of time in the long run, if you can use some or all of the information from a previous PRA.

It will also help to ensure a consistent approach to PRAs by providing a template or format to follow, and providing a lot of background information or references that may still be pertinent. It will also help to ensure a consistent and transparent approach to the specific issue at hand, whether it's a particular pest or a commodity, by providing a record of what was known earlier and what position was recommended at that time.

It is helpful to have a system of filing or storing PRAs as they are completed so that they are more easily retrieved later as part of this step in the PRA process.

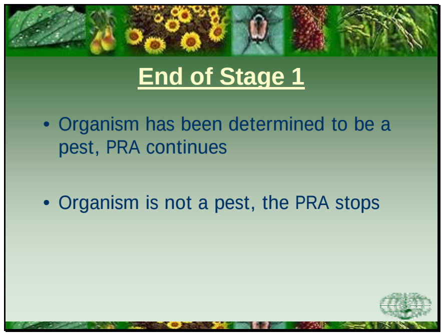
Slide 30



Remember this process could result in a single species being identified or a list of species, as in the case of a pathway-initiated PRA

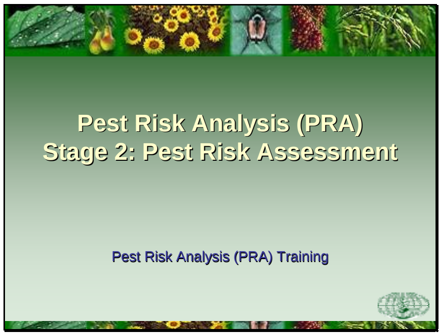
At this point, all we know about the organism is that under some circumstances it could or does have an impact of some magnitude on plants, i.e., it doesn't affect animals, it affect plants. We have made no assessment of the risk it presents, nor come to any conclusions about what measures, if any, should be taken against it.

Slide 31


End of Stage 1
• Organism has been determined to be a pest, PRA continues
• Organism is not a pest, the PRA stops

Categorization

Slide 1



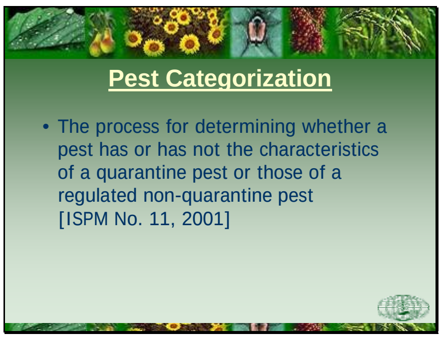
Slide 2

Slide 3

This slide shows where we are in the overall PRA process. The stages and steps can be confusing and difficult to follow. This slide will be shown at the beginning of each lecture, and the bold type indicates the stage/step that will be covered in the lecture.
The "PRA overview" talk this morning gave a brief introduction to the whole PRA process, and now we will spend the rest of the week working our way sequentially through the stages and steps, covering each one in more detail.

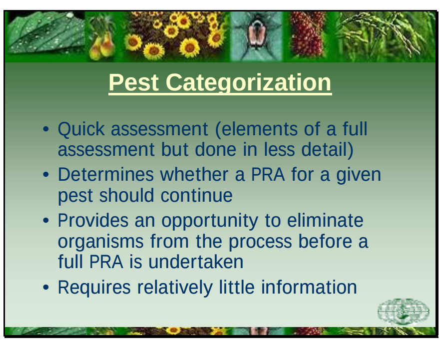
The preceding talk covered Stage 1 (Initiation), and now we will move into Stage 2, the pest risk assessment process, with the first step, "Categorization".

Slide 4



Regulated non-quarantine pests were mentioned briefly in the PRA overview lecture this morning. They are not the focus of this course, and the discussions that follow will focus on quarantine pests only. If a pest was found to meet the definition of a regulated non-quarantine pest, the PRA would follow ISPM No. 21 instead of 11, but the process and principles are essentially the same.

Slide 5

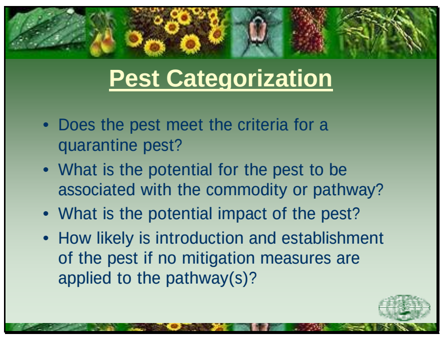


Categorization is a process applied to a single pest (usually a species). While the initiation stage may begin with consideration of a pathway, pest, or policy, the outcome of initiation will be a single pest, or in the case of a PRA initiated by a pathway, a list of pests. Each step of the PRA process from this point forwards is applied to each individual pest in turn.

For each pest, the categorization process:
Is a quick assessment with all the elements but less detail than a full assessment
Determines whether the PRA should continue

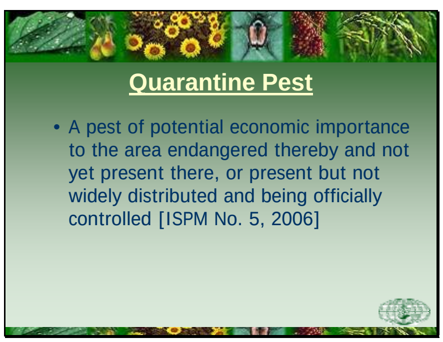
Overall, categorization is a kind of "screening". It takes organisms identified in the initiation stage that were deemed to be pests in the IPPC context, and looks at them in a bit more detail to decide if they merit a full PRA. It requires relatively little information (relative to a full PRA), and is an important opportunity to eliminate organisms from the process and prioritize, or focus, the PRA resources of a given country. (i.e. full PRAs cannot be done for everything).

Slide 6



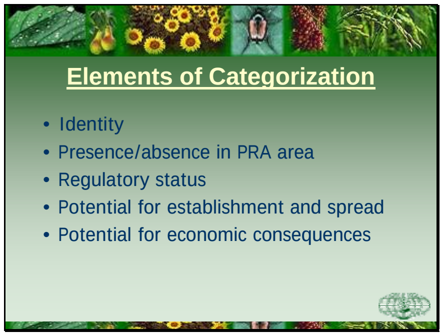
These are the types of questions that are asked in the categorization process. If the pest satisfies the definition of a quarantine pest, expert judgement may be used to review the information collected to this point to determine whether the risk from the pest is acceptable or unacceptable. If the pest has potential economic importance and establishment is possible within the PRA area, the PRA may continue. If not, or if the risk is deemed to be acceptable, the PRA may stop at this point.

Slide 7



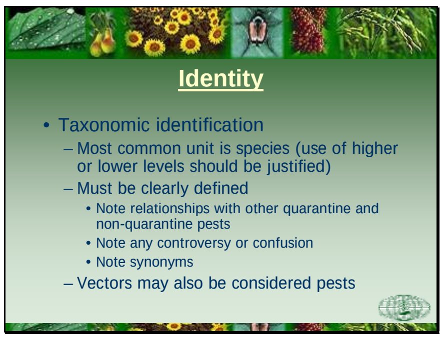
This is the official IPPC definition of a quarantine pest, which you have seen before and will see again throughout the remainder of this course and in fact several more times in this lecture. The categorization process is essentially about determining whether a given organism meets this definition. We will be coming back to this definition over and over throughout the discussion.

Slide 8



These are the elements of categorization; the elements that will be considered for each pest in the process. We will now take each one and talk about it in more detail.

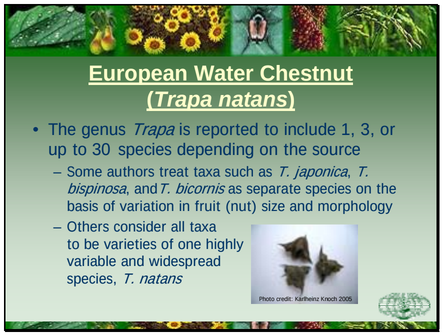
Slide 9



The identity of the organism is fundamental to the PRA process, and should be defined as clearly as possible from the outset. This seems obvious but can be more complicated than you think when an organism is new to science, or when taxonomic differences arise. The way the identity of an organism is defined from the beginning may affect what information is then gathered about it, and in turn the decisions that are made on the basis of that information.

The most common unit for conducting a PRA is species. ISPM No. 11 states that higher or lower taxonomic levels may be used, as long as that use is supported by a scientifically sound rationale.
Familiarity with synonyms, taxonomic position, and relationships with other organisms will all help in defining the identity of the pest. It is also important to clarify any controversy or confusion that surround the identity of the pest. Where a vector is required for dispersal of a pest, the vector itself may also be considered a pest

Slide 10



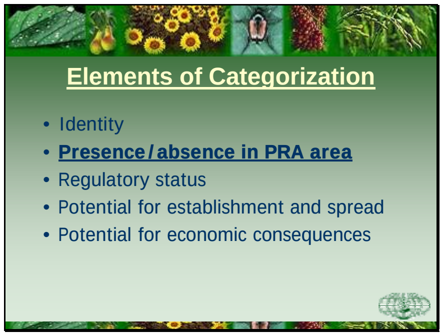
This is an example to illustrate the importance of defining identity. *Trapa natans* is an aquatic plant that is considered invasive where it has been introduced in North America. (As an interesting aside, it is protected as a threatened species in parts of its native range in Europe, and is cultivated as a food source in Asia). The genus *Trapa* includes either 1, 3, or up to 30 species depending on the source, and the author. Some authors believe there is just the one species, *Trapa natans*, with many different varieties. Other authors treat each variety as a separate species. At the outset of a PRA on "European water chestnut" a decision would have to be made as to which taxonomic entity was being considered. The risk assessor may want to consider information published under other species names (e.g. *T. japonica*; *T. bispinosa*), in addition to *T. natans*. The inclusion (or exclusion) of this information could influence the outcome of the PRA.

Slide 11

This is another example to discuss with regard to "identity"; in particular, how to deal with uncertainty about identity.

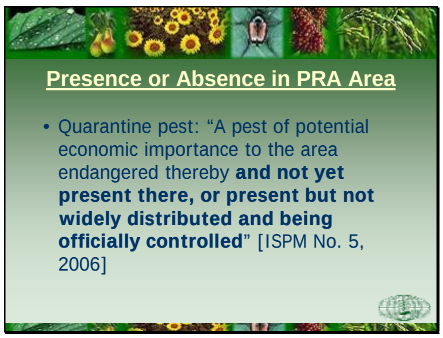
When *P. ramorum* was first detected causing disease in oaks in the USA in the 1990s, it was not known what the species was. The damage was significant enough that there was a need to conduct a PRA right away. The organism was defined as accurately as possible, and a PRA was completed using information from other *Phytophthora* species that were thought to be closely related (specifically *P. infestans* that causes potato blight, and *P. lateralis* that causes Port-Orford cedar root rot). The important point is that a PRA can be done using the best available information at the time. The resulting PRA in this case had a lot of uncertainty, but identifying sources of uncertainty keeps the process transparent and may also help to focus research effort. Note that not doing a PRA, or waiting to do one, due to lack of information, may introduce other risks.

Slide 12



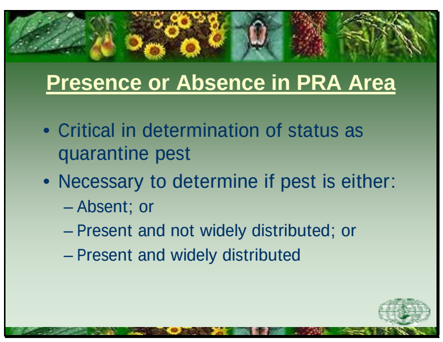
Once the identity of the organism has been determined as clearly and accurately as possible, the next step is to determine presence or absence in the PRA area.

Slide 13



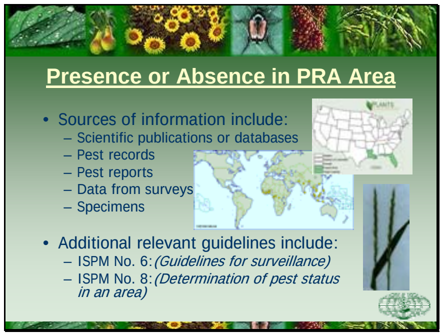
This shows the reference to presence/absence in the PRA area in the definition of a quarantine pest.

Slide 14



As seen in the definition, presence or absence of an organism in the PRA area is critical in determining its status as a quarantine pest.

Slide 15



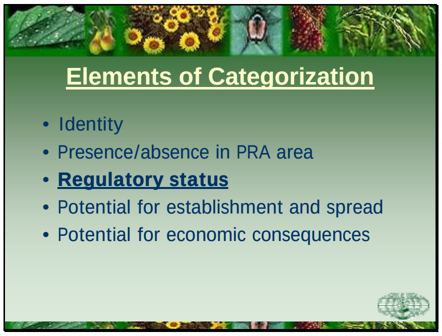
This slide lists a number of different sources that can be used to determine presence/absence and distribution of a pest in a PRA area, as well as a couple of relevant ISPMs.

Different sources will provide different scales of distribution data and different degrees of accuracy. Databases such as the USDA PLANTS database (map shown here for *Citrus sinensis* (orange)) and the CABI CPC (map shown here for *Rastrococcus invadens* (mango mealybug)) are often available online, and are quick and easy ways to check distribution at the country or state level, although they may sometimes contain mistakes arising from misidentifications or mistaken reports in the literature, or simply from not being updated regularly. Primary scientific publications may be consulted for more detail, and published floras of an area are often a good source of reliable distribution data. Pest reports and data from surveys might be the best way to get detailed and emerging information about a pest in a new area. The greatest degree of certainty about a species' presence in an area may be obtained by checking herbarium specimens (scan of *Elytrigia repens* (couch grass / quack grass) shown here), although this requires significantly more time and effort. The level of confidence and scale required for the distribution data may vary from case to case.

Slide 16

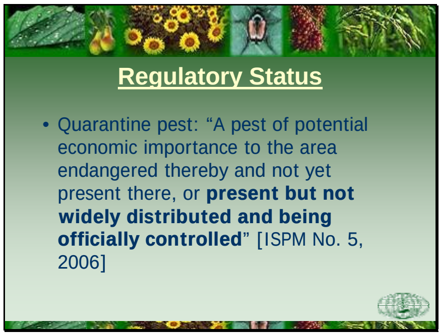
This shows a map of CFIA survey data for Asian Gypsy Moth (surveys are another potential source of information about a pest's distribution).

Slide 17



The next element to discuss is the pest's regulatory status.

Slide 18



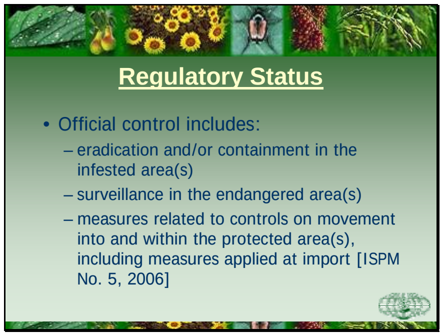
If the pest is determined to be "present but not widely distributed" in the PRA area, then it must also be "being officially controlled" in order to meet the definition of a quarantine pest

Slide 19

Determination of whether a pest is being "officially controlled" can be assessed by considering the IPPC definition.

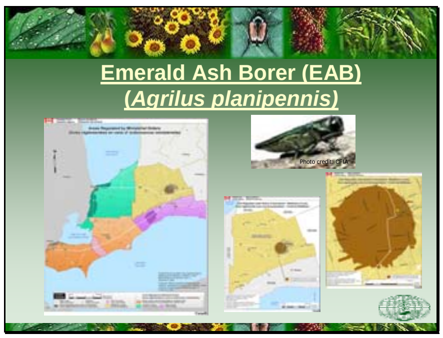
Note the use of the terms "active enforcement", and "mandatory" – meaning that all persons involved in official control are legally bound to perform actions required.

Slide 20



These are some of the phytosanitary regulations/procedures that might be considered official controls.

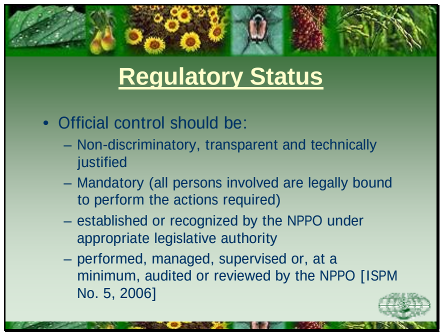
Slide 21



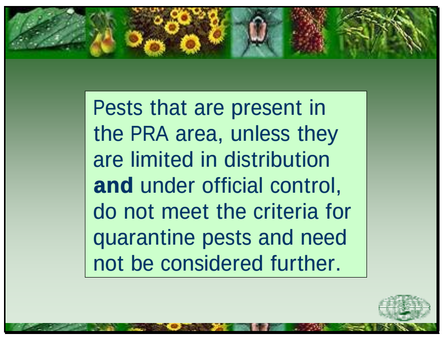
This is an example of official control taken by the Canadian Food Inspection Agency against the Emerald Ash Borer (EAB) in southwestern Ontario. The map on the left shows the areas regulated under ministerial orders (orange, green, purple). Regulated materials can be moved freely within a regulated area, but cannot be moved outside the regulated area without written permission from the NPPO. Regulated materials in this case include any ash products (nursery stock, trees, logs, wood, rough lumber including pallets and other wood packaging materials, bark, wood chips, or bark chips) and firewood of any other tree species. The pink stripe across Essex county (orange) indicates an “ash-free zone” that was created in 2004. All ash trees were removed from the zone in order to discourage the spread of EAB. Since then, however, EAB has been found Elgin and Lambton counties (purple and green) and most recently, in London, Ontario, as indicated by the brown dot in Middlesex county (yellow). This location is shown in close-up in the other two figures.

This control program is aimed at trying to contain and eradicate the pest within infested areas, and to stop the spread of the pest to endangered areas. Compliance with the regulations is mandatory, and enforced by the NPPO. Surveillance activities are ongoing to map the spread of the pest.

Slide 22



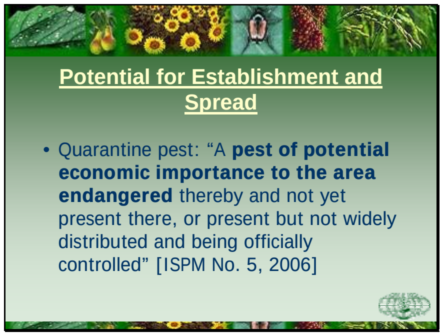
Slide 23



Slide 24

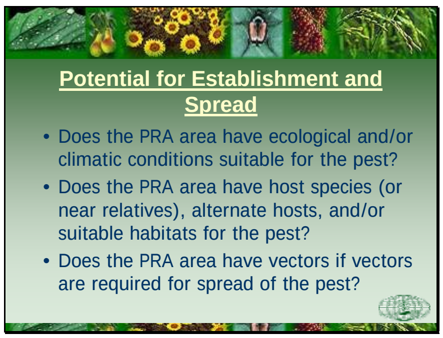
For pests that are absent from the PRA area, or present but not widely distributed and under official control, the next step in categorization is to consider potential for establishment and spread.

Slide 25



This shows the link, once again, with the definition of a quarantine pest. In order for a pest to be of potential economic importance in an area, it must (a) have the potential for establishment and spread, and (b) have the potential to cause economic consequences.

Slide 26



These are the main questions that may be asked with regard to a pest's potential for establishment and spread. Remember to consider protected conditions as well as outdoors, where applicable (e.g. when plants are grown in greenhouses or glasshouses), and to analyse all important biotic and abiotic factors (e.g. climate, soil type, host range, vectors, etc).

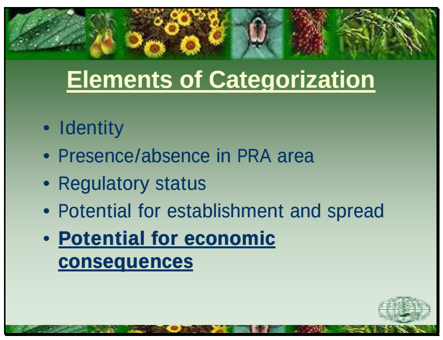
Slide 27

The pest's potential for establishment and spread in a new area is usually based on its known distribution (and where applicable, history of introductions). Known distributions are often available in the form of distribution maps (map shown here from CABI CPC for the banana weevil). For example, if you were conducting a PRA for Canada, a tropical distribution like this might immediately suggest to you that the pest is unlikely to be able to survive in the PRA area.

Slide 28

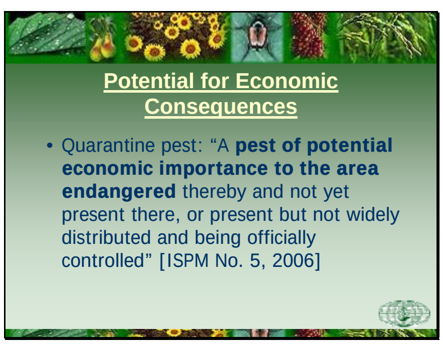
Likewise, if you were doing a PRA for South America, a temperate distribution like that of the Colorado beetle would be a first indication that the pest is unlikely to establish and spread in the PRA area. If the pest cannot survive in the PRA area, it will not have an economic impact and the PRA process can stop here.

Slide 29



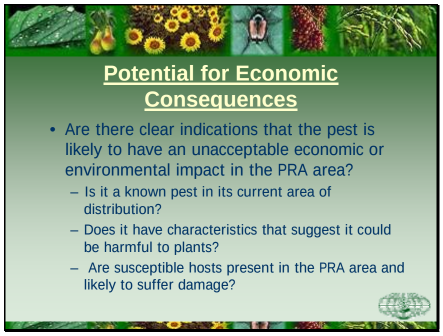
If the pest seems likely to be able to establish and spread in the PRA area, the next factor to consider is its potential for economic consequences.

Slide 30



Just another reminder of where this fits into the definition of a quarantine pest

Slide 31

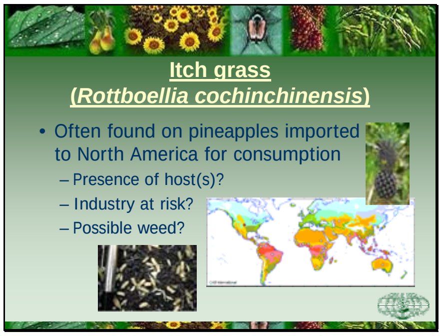


These are the main questions that may be asked with regard to a pest's potential to cause economic consequences.

Slide 32

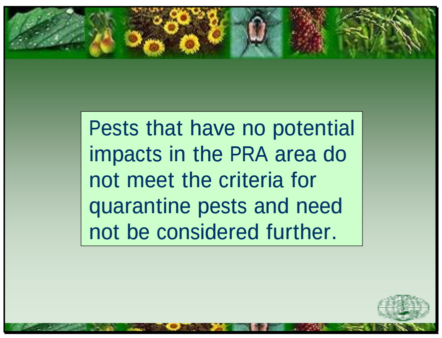
For example, at one time Canada received a request to import a new, cold-tolerant rice variety for cultivation trials. Because of the cold tolerant trait it would be likely to survive in the PRA area. However, rice is not presently cultivated in Canada, so there is no industry that would be placed at risk with this import. In addition, because rice is not generally cultivated in cool-temperate areas, many of the more serious seed-borne rice pathogens also do not occur in cool-temperate climates, and most appear to have relatively high optimum growth temperatures. An additional consideration is whether rice itself could be invasive, and therefore meet the definition of a quarantine pest. However, rice is not reported as an invasive weed in the literature. In a case like this, the potential economic impact may be considered minimal and the PRA process could stop here.

Slide 33

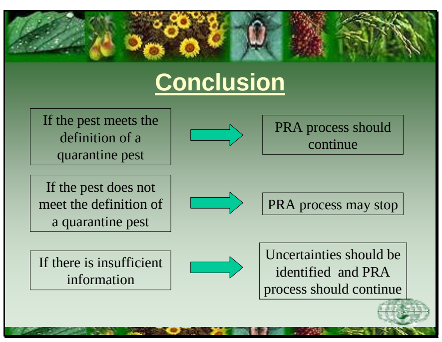


Another example that illustrates this is the case of itch grass, which is often found on pineapples imported to North America for consumption. Itch grass is a serious weed in some parts of the world, but primarily in tropical or subtropical climates. In more temperate climates it may be less likely to establish and spread, thus causing economic impacts. The end use of the commodity is another important consideration in this case, as pineapples for consumption are a lower risk pathway for introduction of a weed than, for example, seed for planting, or even grain for animal feed.

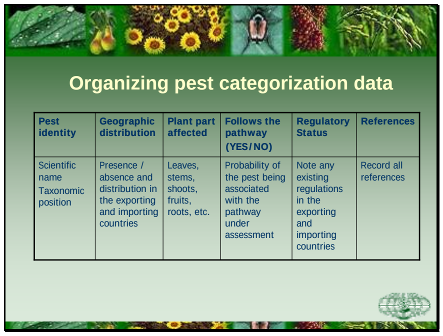
Slide 34



Slide 35

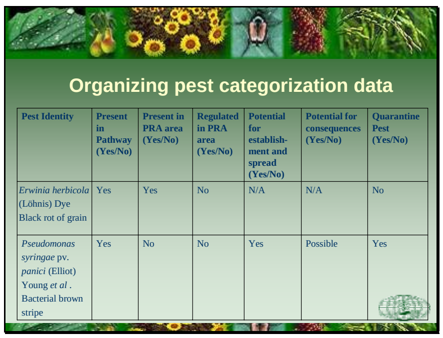


Slide 36



In cases where the PRA has been initiated by concern about a pathway, there may be a list of pests that need to be categorized individually. In such cases, it may be helpful to organize the information in the form of a table. This example shows some possible column headings that may be helpful in organizing pest categorization data.

Slide 37



This is another example, with some pests included. Different countries have different ways of organizing these tables, but a table of some sort is often found in a pathway- or commodity-based PRA. It provides a quick reference to see which of the pests identified have been “screened out” at the categorization stage, and which ones will require the PRA process to continue.

Risk and Probability

Slide 1

Slide 2

A critical thing to remember is that there are two facets to pest risk – the likelihood of encountering that pest, and the magnitude or the impact of that pest if we do encounter it
In the IPPC world, we think about risk in terms of these two factors
We say that pest risk is a combination of likelihood and impact

Slide 3

Pest risk assessment is about assessing these two factors to make a determination about the overall pest risk
A pest risk assessment asks three pretty basic questions to make that determination
What bad thing could happen? This is the question we answered when we identified the pest for which we are conducting our PRA and categorized it as a potential plant quarantine pest. The bad thing that could happen is the pest in question. In the photograph, we see a Japanese beetle, *Popillia japonica*, an introduced pest in North America where it causes damage to a wide range of horticultural crops in

areas where it has become established.
The next two questions address the two facets of risk – namely likelihood and impact
How likely is it to happen? What is the probability that the pest will be introduced and spread in the PRA area?
And How bad will it be? What are the potential economic and environmental effects that we might expect if introduction and spread occurs?
The IPPC PRA standards provide much more detailed guidance in the kinds of things to consider in completing a pest risk assessment; they go into a great deal of detail but fundamentally ask the same two basic questions – How likely? How bad?

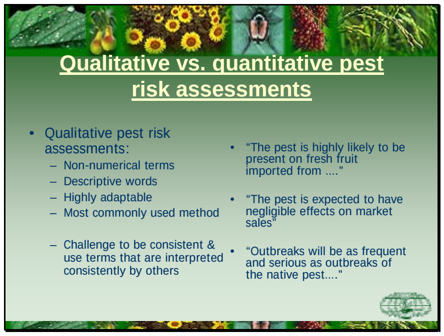
Slide 4

Likelihood can be expressed in a number of ways
Equivalent words that are commonly used to describe this half of the risk equation include “likelihood”, “potential” and “probability”
It may be used in a quantitative or mathematical way
Or it may be used in a descriptive or qualitative way
The important thing to remember is that this facet of pest risk refers to the **relative possibility** of pest risk occurring

Slide 5

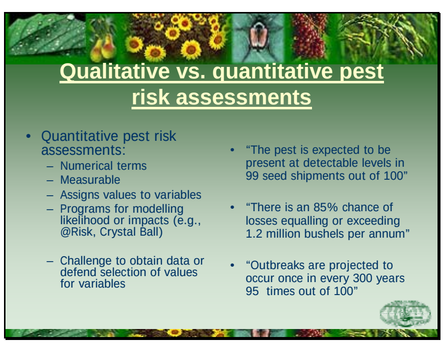
Likewise, impact can be expressed in a number of ways
The IPPC standards provide for consideration of both economic and environmental impacts, including also social impacts in the kinds of effects that may be considered in assessing pest risk
Equivalent words that are commonly used to describe this half of the risk equation include “effects”, “consequences”, “impacts” or “importance”
Impacts may be expressed in a quantitative or mathematical way
Or they may be presented in a descriptive or qualitative way
The important thing to remember is that this facet of pest risk refers to the **relative magnitude** of the event

Slide 6



Pest risk assessments may be either qualitative or quantitative
The ISPMs do not specify one approach or another, but indicate that the approach taken should be consistent with the standards
Each has its own merits and may be suited to particular purposes
An NPPO may elect to use the method that most suits its needs and is most suitable for the assessment in question
A qualitative pest risk assessment uses non-numerical terms – descriptive words, such as "highly likely" or "not at all important", to describe a situation
These descriptive words are highly adaptable and can be used to distinguish an array of values effectively
The bullets on the right provide some examples of statements made in quantitative pest risk assessments – statements like (*read or paraphrase the statements)*
Qualitative methods are the most commonly used pest risk assessments methods used currently
Nonetheless, quantitative methods have some limitations and present some challenges – the difficulty lies in ensuring consistency between assessments and between assessors in one NPPO, and in communicating with other NPPOs
This is because quantitative methods rely on words and words can be translated or interpreted with the result that they may no longer have the intended meaning

Slide 7



Quantitative risk assessments on the other hand use measureable, numerical terms to describe a situation
Numerical values are assigned to variables such as likelihood of introduction, spread potential or economic impacts
Risks are described using terms such as "85% chance of losses equalling or exceeding 1.2 million bushels per annum" or "outbreaks once in every 300 years 95 times out of 100"
Quantitative pest risk assessments often use models to describe or predict variables; potential extent of distribution, spread, economic impacts, and other elements assessed in a pest risk assessment may be modelled, using

predictive modelling tools such as @Risk , Crystal Ball and others

While a quantitative risk assessment addresses some of the challenges posed by a quantitative approach – more consistent interpretation, reliably translated and communicated – it presents its own challenges

Quantitative risk assessments may pose difficulties due to the absence or incomplete nature of the available data, for example

The selection of variables and the assignment of values to those variables may additionally present difficulties and subject the assessor to challenge

Slide 8

The most important point in this discussion is that there is no single correct model for pest risk assessment; the approach taken should be consistent with the IPPC guidelines, it should be readily communicated, and easily explained; beyond that, the method selected should suit the NPPO's needs and be fit for the purpose intended.

While it serves an NPPO well to have a well-articulated model for its PRAs, one which reflects its resources and requirements, each PRA is unique to some extent and presents a different selection of challenges to the NPPO

There are many factors which an NPPO may need to consider in selecting the methods to be used in a particular PRA - such as, the urgency of the situation – if an answer is required immediately, it may be better to opt for a qualitative pest risk assessment, using what data is available very quickly

If the issue is a very serious one, in which there is concern that very high impacts may be anticipated, then a more in-depth pest risk assessment may be necessary to make the best possible decisions

An issue which is very sensitive must be handled very carefully, and an NPPO may select a very detailed, quantitative risk assessment model in this circumstance

Likewise, the availability of data, or human or financial resources, and the needs of the NPPO will influence the pest risk assessment model selected

Both quantitative and qualitative methods have good points and bad points -- pros and cons

These should be considered by the NPPO in selecting a model to use in any particular situation

A common option is to select a combination of the two methods to address different parts of the assessment

It is not unusual for a pest risk assessment to be comprised of quantitative elements and qualitative elements; some things, such as potential economic importance are more amenable to quantitative methods, whereas environmental or social impacts may be better assessed using qualitative methods

Likewise, certain elements of likelihood, entry potential for instance, may lend themselves well to quantitative methods of assessment, while others such as establishment potential may not.

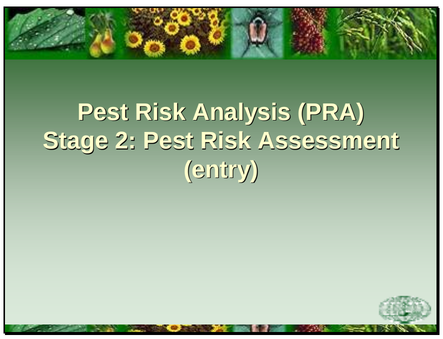
In all cases, however, the pest risk assessment focuses on the same basic elements and answers the same basic questions – How likely? And How bad?

Our focus this week will be on quantitative methods, but while you are working on parts of the PRA, think about how it might be adapted or what information would be needed to adopt a quantitative method

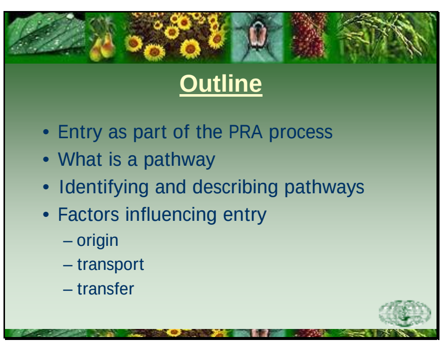
Probability of Entry

Slide 1

Slide 2

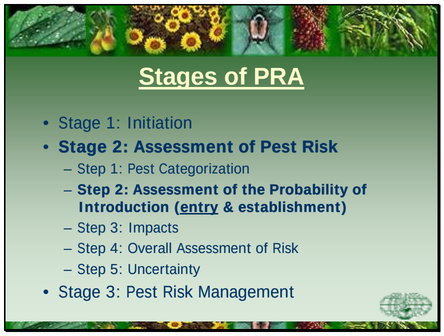


Slide 3



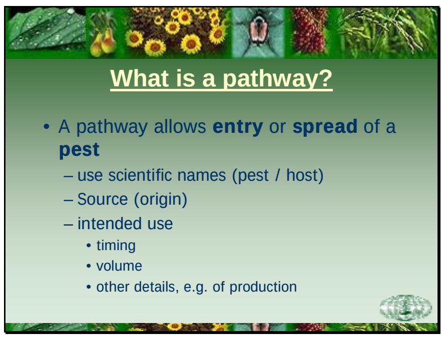
In this presentation we will discuss entry as part of the PRA process, what is a pathway, identifying and describing pathways, factors influencing entry (origin, transport and transfer).

Slide 4



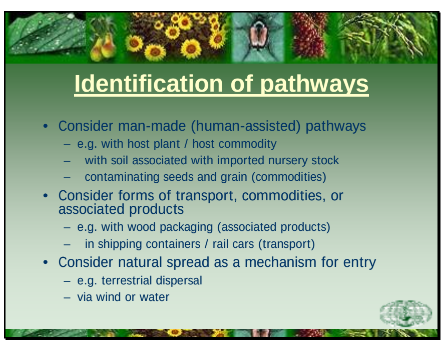
Stages of a PRA...Considering entry comes under Stage 2: Assessment of Pest Risk and within Step 2 of the assessment – Assessment of the Probability of Introduction. Introduction includes both entry and establishment but here we will first discuss entry.

Slide 5



A pathway is something that allows entry or spread of a pest. When describing a pathway, try to use scientific names of the pest and the host, describe where it's coming from, the origin and the intended use, details on timing, what time of year it occurs, any volume information you have, and other details about production could also be useful.

Slide 6



When identifying pathways it is important to consider man-made and human-assisted pathways. The most obvious example is one with host plants or host commodities such as fruit and vegetables that may carry the pests. It is also important to consider things associated with the host plants or host commodities such as soil with imported nursery stock or imported plants or seeds contaminating grain in commodities.

Forms of transport are also important to consider: how they are carried. An example of this is wood packaging that is carrying plants on pallets or wooden boxes in shipping containers or in rail cars or carriages.

It is also important to consider natural spread as a mechanism for entry. Spread by terrestrial organisms could be by walking and crawling on the ground. Spread by air is also possible - it could be carried in the air currents by the wind or fly. Things like seeds could float in water and be spread in that manner.

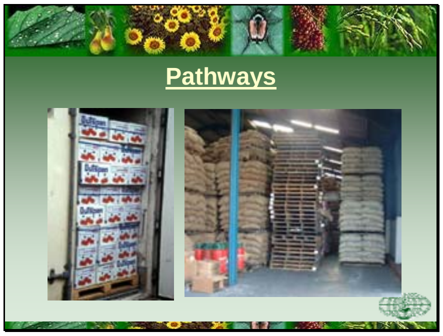
Slide 7

Here are some pictures displaying international trade in plants, and in some cases whole trees.
The range of imported tree species available to buy worldwide is enormous. For example one company in England offers more than 30 species of palm to grow outdoors; and a larger number to grow under protection. Many of the exotic trees are imported from the Americas, Asia and Australia via Holland. These pictures are taken from the website of the largest European importers of exotic trees.

Here are some examples some tree ferns from Aus or NZ harvested, put into a ship then in the back of a truck and transported into Europe.

On the right are plants on trolleys at nurseries as well as with the hosts or commodities themselves, the packing materials.

Slide 8



This slide shows outspan oranges, on wooden pallets and grain and seeds in a warehouse. Note the wooden packages nearby the things that could carry pests.

Slide 9

Here is an example of *Tecia solanivora*, Guatemalan potato moth. The moth is on the right hand side, while the left hand side shows bags of potatoes in the hold of a ship.

Slide 10

This slide shows a map of the world. The yellow dots are showing the distribution of the Guatemalan potato moth in Central and South America. The map is from the CABI CPC. The moth was first identified as a pest of potatoes in Guatemala. It spread in Central and into South America and then it was reported in the Canary Islands.

Slide 11

This shows a red arrow going to the Canary Islands from Central and South America.

Slide 12

The Canary Islands are a Spanish territory and thus part of the European Union. There is trade between them and Europe so potentially the moth could get into Europe through trade in potatoes from these islands.

Slide 13

We'll now talk about *Diabrotica virgifera virgifera*, Western corn root worm. This pest of maize is a significant pest in North America. In the early 1990's, it was reported in the former Yugoslavia near Belgrade. It probably arrived either with military transport following the war or with food aide after the Balkans conflicts. This colour map shows the spread of the pest. Each year the beetle has spread out from the focus in the former Yugoslavia. Each colour represents a different year, see the key on the left hand side. It's moving out with different rates each year and it's spreading naturally. It's walking and flying from where it was first introduced. So from Yugoslavia, it has entered Bosnia-Hertzegovina, into Croatia, Hungary, the southern part of

Slovakia, and east into Romania and Ukraine.

Slide 14

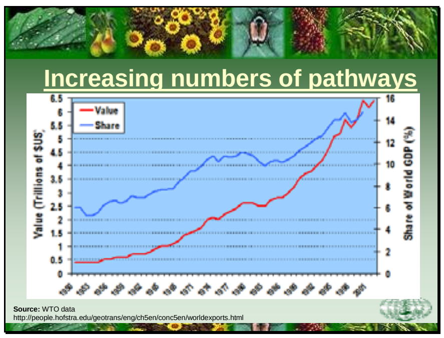
Actual isolated satellite populations are showing up in Italy around Venice and the Milan airport and also around Paris in France

This slide shows further spread in mainland Europe and also isolated pockets around international airports in Northern Europe, around Britain, the Netherlands, and Belgium. These could be separate introductions - genetic analysis has shown that there has been at least three separate introductions from the US into Europe. All are associated with air transport. Maize plants are not transported, so it is not clear by what mechanism the pest is spreading. It's been hypothesized that the beetles might be attracted into airports at night by the lights and then they get into the holds or undercarriages of airplanes. As the planes come in to land, the undercarriage opens and the beetles drop out. Land around airports is often flat and good for growing maize. The beetles might drop out of the airplanes on to maize crops near airports and develop populations. This is just speculation but it is a possible pathway for entry.

Slide 15

In recent years there has been an increasing number of pathways...
Plant pests have always been spread via man's activities
The World Trade Organisation (WTO) has broken down trade barriers
And global trade dramatically increased during 20th Century

Slide 16



Here we see a graphical representation of exports of merchandise from 1950-2003. This graph shows time on the x-axis 1950-2003, the value of exports in trillions of US dollars on the left y-axis, and the share of the world gross domestic product (GDP) on the right y-axis. Both values increase dramatically over the time span of 53 years. This graph shows that not only did the value of trade increase but reliance on trade did as well.

Slide 17

Trade data changes over time. Here is an example from the UK. In 1991, imports of cut flowers were just over 50 thousand tonnes. In less than ten years the quantity of imports more than doubled to over 102 thousand tonnes imported in 1998. They come from all over the world and the countries listed here are only a fraction of the countries exporting cut flowers to the UK.

Slide 18

Here is just a written example of a pathway and how you could describe it. In other words, how you might describe apples, *Malus pumila*. Notice that the information includes the Latin name. It is important to be specific and use the common and scientific name, the binomial name, whenever possible. So…apples (*Malus pumila*) fresh fruit from NZ to Aus for consumption. Here you are identifying what it is – being as specific as possible - what the commodity is, what the host is. Including what type it is (fresh fruit), the source (from NZ), what it's being used for (for consumption) and where it is going to (Australia) are essential pieces of information as well.

Another example, potatoes, *Solanum tuberosum*, from Egypt to Germany for processing into french fries. This example includes similar information to the apple example.

Another example but with more detail, Rose cut flowers (*Rosa*), from Columbia via weekly air freight to the USA for wholesale auction and retail in florists. Here we have another description of a pathway with more information. You have information on the host including the scientific name-*Rosa* and type-cut flowers and the source-Columbia. Additionally, you have timing-weekly air freight-and the route-by air from Columbia to the USA. When it arrives it is being sold at an auction wholesale and then in florists.

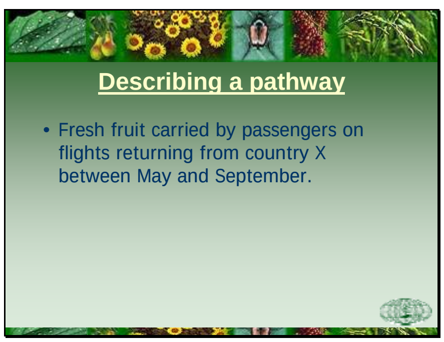
The more information you have to describe a pathway, the easier it is to answer the types of information questions you need when doing a PRA.

Slide 19

Here's another potential example, grapevines, *Vitus*, from South Africa to Chile for planting and fruit production. This may not be an actual example, *Vitus* from South Africa may be banned into Chile – it would depend on the requirements or restrictions of Chile.

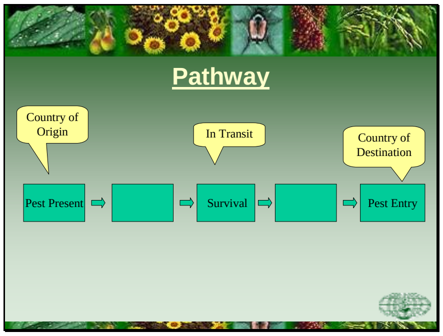
Here's a slightly different one. Stone and quarried slate from China to northern Europe for use in the building and landscape industry, transported on ships arriving monthly and carried on solid wood packaging. The risk here is the solid wood packaging-not the product. Some of you might be aware that Asian long-horned beetle and other cerambycid beetles have been transported around the world probably in solid wood packaging. They aren't necessarily associated with plants or the products being transported just with the packaging and other materials. In Europe, there has been a number of findings of Asian long-horned beetles around importers, where they are importing slate and stone from China.

Slide 20



Another example of a pathway – fresh fruit carried by passengers on flights returning from country X between May and September. This example is again a bit different. We are not specifying an individual fruit and therefore not giving a scientific name for a single fruit. It is for a variety of fruit species so potentially we are going to be considering a number of pests, fruit flies for example perhaps. A country is identified, it isn't given here, but it could be a country that we are particularly worried about, which is know to have a certain fruit fly. In the meantime, there is that risk between May and September. That time is perhaps when the most passengers will be returning perhaps with those fruits smuggled in. These are just speculative pathways, with examples of the sorts of ways you could use for describing them.

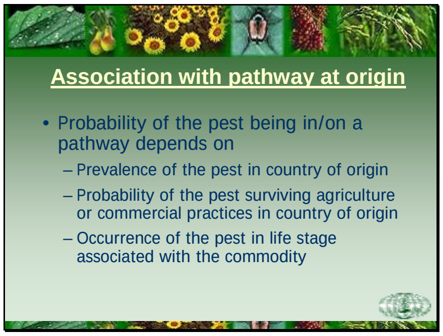
Slide 21



This is an example of a scenario diagram developed to illustrate the movement of a theoretical plant pest from a country of origin to a country of destination. The green boxes illustrate the points along the pest's journey.

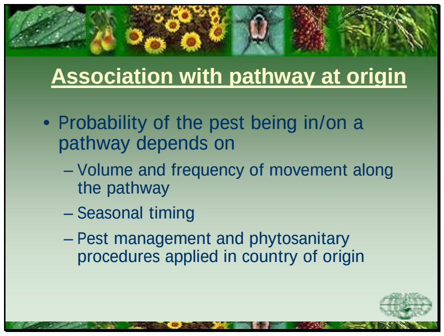
In order for entry to occur the pest must be present in the country of origin, survive transportation and find a suitable host (transfer to a suitable host)

Slide 22



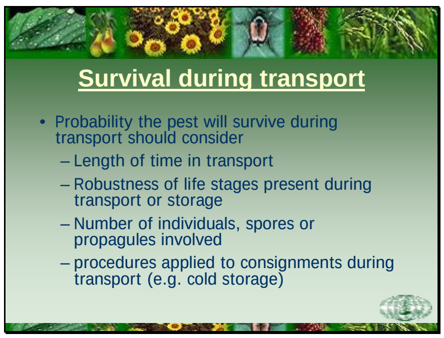
It is important to consider for entry, that the pest has to be associated with the pathway at the origin-where it comes from. For potatoes from NZ moving into the UK the pest has to be associated with the crop at harvest. The probability of the pest being in or on a pathway and what that depends on needs to be considered. The prevalence of the pest in the country of origin and other factors such as whether the pest can survive agriculture or commercial practices in the country of origin should be taken into account. The likelihood of the life stage being associated with the commodity is also considered. For example, if it is a leaf eating beetle on a potato perhaps the chances of adults being associated with exports of potatoes are very low because the leaves will be gone. Only the tubers are harvested and exported so the potato leaves aren't shipped. The adults are therefore not going to be associated, however the larvae perhaps could be if they are larvae that feed or burrow into tubers. That may not be the case, but that is information that would be needed.

Slide 23



The probability of the pest being in or on a pathway depends on a number of factors.
The volume and frequency of movement along the pathway can alter the probability of association.
The seasonal timing of the pest has to coincide with the time of it being on the crop at the time when it is harvested as mentioned before.
The pest must evade or survive pest management and phytosanitary procedures applied in the country of origin.

Slide 24

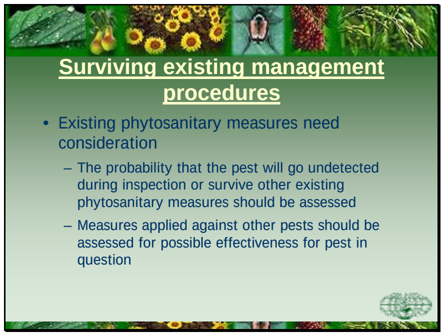


Once the commodity is harvested and assuming the pest is associated with the crop, then it must survive transport the enter the importing country. If the commodity is being air freighted perhaps, it's a very rapid transport, the pest might well survive. If the commodity is transported in a ship, a very slow transport, the pest might not survive because it takes too long.

Survival depends on...
the length of time in transport,
the robustness of the life stages present during transport or storage,
and the number of individuals, spores, or propagules involved.

Other factors to consider about survival during transport are...
Procedures applied to consignments, perhaps it might be shipped in cold storage which might kill off some pests.
Existing phytosanitary procedures that might be used against other organisms, but that might have an effect on the organism that you are studying

Slide 25



The probability that the pest of concern will go undetected during inspection or survive other measures should be assessed. Perhaps, measures applied against other pests should be assessed for possible effectiveness for the pest in question.

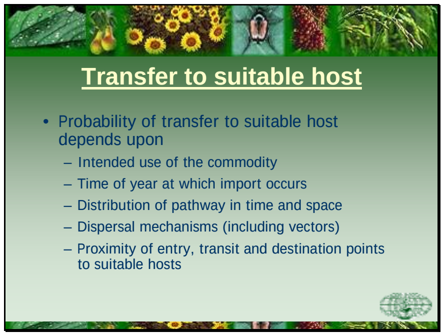
Slide 26

Here's a picture of some inspectors doing inspections at an airport. They found a suspect pest and sent them in to a laboratory to be identified.

Slide 27

Here is a diagnostician looking at some material using the microscope. On the right is a range of fruit showing some paperwork and the fruit with pests on them.

Slide 28



Once a pest has entered a country, it must move and transfer to a suitable host.
The probability of transfer depends on a number of things:
the intended use of the commodity,
the time of year at which the import occurred,
the distribution of the pathway in time and space,
the dispersal mechanisms-including whether vectors are needed by the pest to spread,
And the proximity of entry, transit, and destination points to suitable hosts.

These are the sort of aspects-that are mentioned in the ISPM-that must be investigated when considering probability of entry.

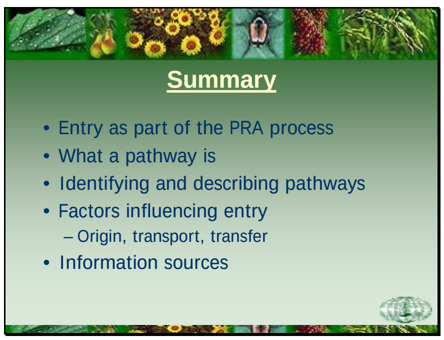
The intended use of the commodity is important. Plants for planting, perhaps held in a nursery could facilitate pest spread because a nursery will have a number of plants and a possibly a number of suitable hosts. The pest could spread from one plant to another because in a nursery they are held quite close together. Planted in a field, there are rows or columns of plants together and a pest of a seed crop in seeds that are sown might more easily get into the soil and then back into the crop in the future and spread. Products like produce that are imported and sold at markets and then cooked and eaten by people, have a lower likelihood of the pest transferring to other hosts. It is reduced because the commodity isn't necessarily going to come into close proximity to other hosts that are living plants that the pest could survive on.

The time of year at which import occurs is also important. If the crop comes from the other side of the world in the summer and is introduced into another part of the world in winter hosts might not be available, they might be dormant.

The more ports of entry in a country into which a commodity enters, the greater the likelihood that there will be hosts nearby. If the commodity comes into many ports and then is transported further widely across a country then the chances are increased that a suitable host will be found by a pest moving from the commodity onto another host.

In contrast, if this commodity comes into a single point, is held there and doesn't move from the port, and then is shipped by a single mechanism to a single destination, there is a lower likelihood of the pest transferring to a suitable host.

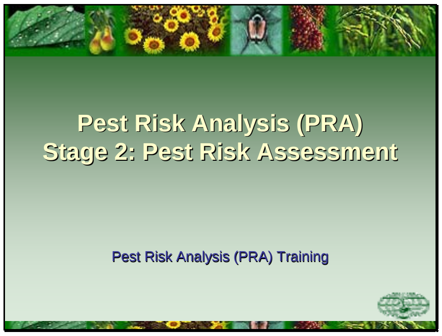
Slide 29



In summary we have considered entry as part of the PRA process, described what a pathway is, thought about how you might identify and describe pathways, and identified some factors that you might consider that influence entry, the origin of transport, the transfer to a suitable host, and considered information sources. Thank you.

Probability of Establishment

Slide 1



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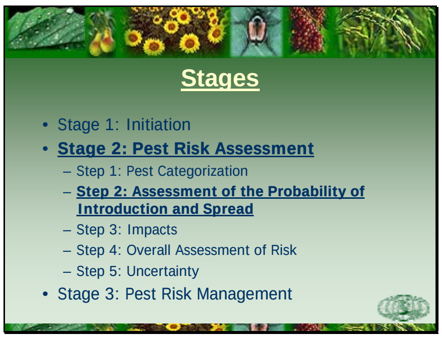
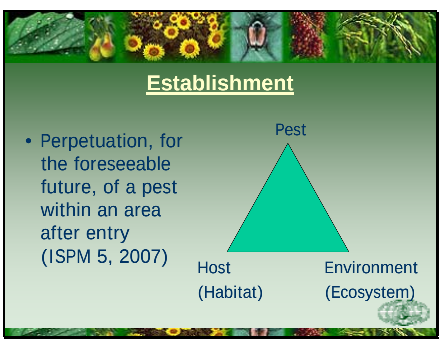


Keep in mind that the IPPC definition of introduction includes entry and establishment. In order to assess the probability of introduction, therefore, we consider the probability of each of these events. This morning we talked about probability of entry. This afternoon we will cover establishment.

Slide 3



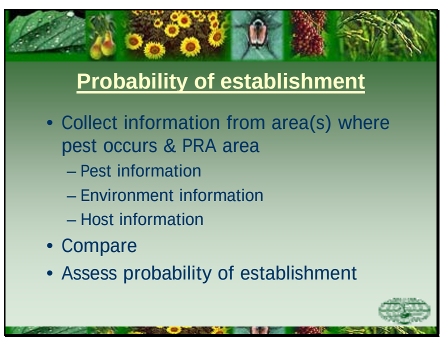
So what is establishment? What does it mean? The IPPC defines establishment as the perpetuation, for the foreseeable future, of a pest within an area after entry. To be established therefore, the pest needs to have found everything it needs to survive and reproduce.

The traditional plant disease triangle identifies three critical factors for plant disease to occur – an organism, its host and a suitable environment – and may be a helpful and simple way to think about establishment. While originally designed to describe plant disease, it can be adapted to demonstrate equally simply the idea of establishment as it is used in the IPPC PRA context.

In order for establishment to occur, three elements must be in place – the pest must be present, its host or hosts must be present, and suitable environmental conditions, such as climate and other abiotic or biotic factors, must also be present. In the case of non-parasitic plants, we can think about habitats instead of hosts, and the triangle still applies.

Evaluating the probability of establishment, therefore, requires evaluation of information about a pest's biology and the conditions that support its occurrence in its current area of distribution, compared with the conditions present in the PRA area. Information about the pest's life cycle, host range or habitat, epidemiology and survival under different conditions may all be relevant to the probability that it will be able to establish in the PRA area.

Slide 4



Evaluating the probability of establishment essentially involves considering information about a pest's biology and conditions in its current area of distribution, and then comparing that with the conditions present in the PRA area. Information about the pest's life cycle, host range or habitat, epidemiology and survival under different conditions may all be relevant to the probability that it will be able to establish in the PRA area.

We can think about assessing the probability of establishment in three steps:

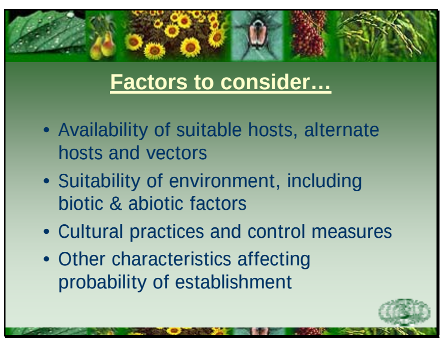
First, we collect information pertaining to the three corners of the triangle including:
biological information about the pest – its life cycle, its hosts, environmental conditions etc. – in the areas in which it is already present,
information about the PRA area – environmental conditions, such as climate, soil types, vegetation, vectors or natural enemies etc., and
Information about hosts in the PRA area – what hosts are present, how

abundant are they, how are they distributed, are they managed or unmanaged etc.

Our second step is to compare the information collected about the hosts requirements in the areas where it is already present, with the information gathered about the PRA area, looking for similarities or differences which would significantly impact the probability of the pest's establishment after entry to the RPA area.

And ultimately, we assess probability of establishment – how likely the pest is to become established in the PRA after entry. Not how serious the impacts would be, or how rapidly it would become established over the PRA area, but how likely establishment is to occur. It may be helpful to build a picture in your mind of the PRA area and imagine what would happen if the pest were to enter – would it find a host, would it be able to survive, would it reproduce?

Slide 5



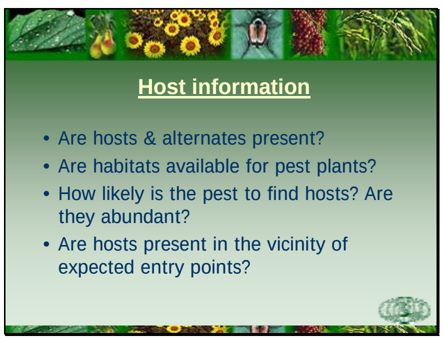
Let's look more closely at some of the factors to consider in this process. What are some of the most critical factors to gather information about and how do these contribute to an assessment of probability of establishment. Our list includes availability of suitable hosts or alternate hosts – don't forget that some species require more than one host to successfully complete their lifecycles – and vectors – again, some species are dependant on vectors for their transfer to new hosts, or to complete their life cycles.

Environmental factors may also be critical factors, and this may include a very wide range of elements from climate, soil type, hydrology, existing vegetation, natural enemies, etc. Each species has a unique set of factors which are important for its perpetuation. There are different techniques available for assessing suitability of environment and a wide range of elements which may be important, so we'll spend a little more time on this topic in a moment.

And don’t overlook man-made environmental factors, especially when assessing a pest in artificial settings such as an agricultural or horticultural pest. Cultural practices and control measures that are already in place in these environments may greatly influence a pest’s probability of establishment following entry in these settings. Sometimes cultural practices will have a negative effect on establishment, but on the other hand, for some pests such as plant viruses may greatly benefit from certain cultural practices and therefore be more likely to become established.

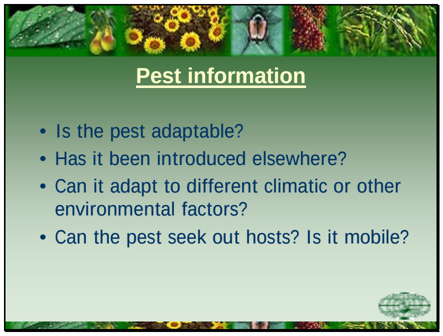
Each pest is a unique character with a unique set of criteria which influence its establishment in any particular PRA area. We’ll discuss briefly some other possible pest characteristics which may be considered.

Slide 6



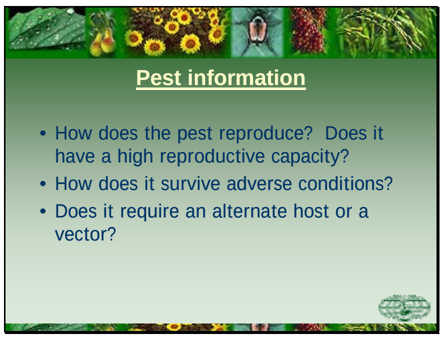
A critical factor to consider is the availability of suitable hosts, alternate hosts and vectors. Are suitable hosts present in the PRA area? Are alternate hosts present? Is the pest host-specific? Is it likely to be able to adapt to new hosts?
In the case of non-parasitic plants that do not have particular host species, consider suitable habitats in this section. Do suitable habitats exist in the PRA area? Does the pest require very specific conditions? Is it likely to be able to adapt to new habitats?

Slide 7



It is also important to consider how likely the pest is to find suitable hosts or habitats. This may be affected by the distribution and abundance of the host or habitats. Do they occur close to the likely points of pest introduction? Do they occur in continuous distribution? Is the pest capable of movement in search of suitable hosts or habitats? For example, a pest like the Japanese beetle may be able to fly towards suitable hosts, whereas a weed like lamb's quarters (*Chenopodium album*) would need to find suitable habitat where it fell; it would not be able to go in search of better conditions.

Slide 8



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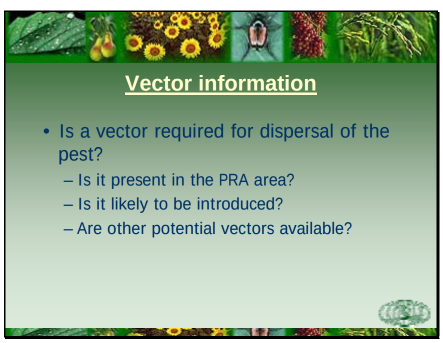
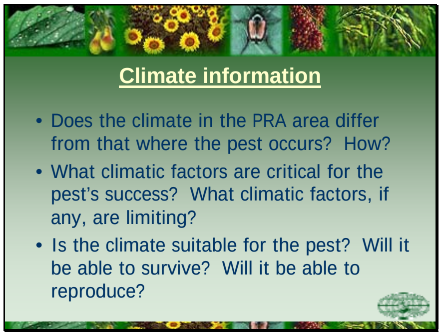


Likewise, for pests whose life history includes one or more necessary vectors, it is also important to consider whether the vector is present in the PRA area, whether it is likely to be introduced, and/or whether other potential vectors are present. If no vectors are present or likely to be introduced in the PRA area, perpetuation of the species, or its dispersal will be unsuccessful or highly limited.

Slide 10

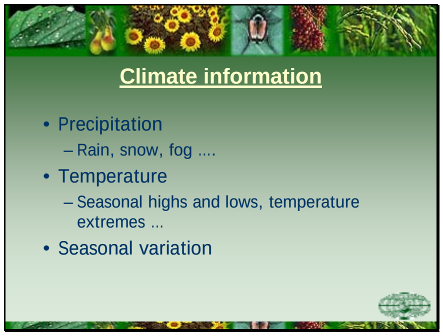


In considering environmental factors, climate is a critical element in determining the fate of a pest following its entry to the PRA area. After all, the distribution and abundance of an organism that cannot control or regulate its body temperature is largely determined by climate.

Climate information from the known distribution of an organism can help predict the potential distribution and abundance of the organism in new geographic regions. In estimating the probability of establishment, the risk assessor should consider the climatic variables which influence the pest's success or failure in other parts of the world, and compare those variables with conditions in the PRA area. We should consider whether or not the climate in the PRA area is different than that in areas where the pest is already established? How is it different? Does it differ in variables that are critical to the pest's survival?

For that matter, what climatic factors are critical? Experimental or observational data may be available to describe the climatic conditions under which the pest will survive or, conversely, under which it will not survive. Identifying critical climatic factors that limit a pest's distribution may be very helpful in determining whether or not it will survive in the PRA area. And, if so, will it reproduce into the foreseeable future and therefore be considered to be established?

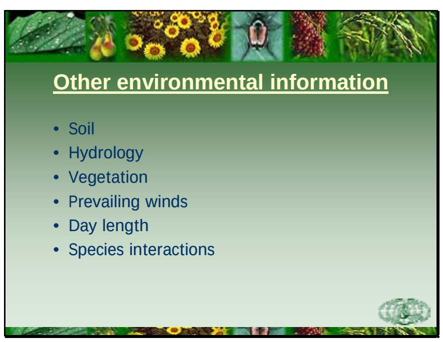
Slide 11



What kinds of climatic conditions might be critical? Each species is a unique case and its survival is influenced by a unique set of variables. Precipitation may be the important element – whether is rain or lack thereof, snow cover in winter, fog in summer. The fungus that causes sudden oak death, for instance, has been shown to be much more successful in areas with prolonged periods of cool, foggy weather, while species of knapweed often flourish in hot, arid conditions.

Likewise, soil or air temperature, or both, may be critical factors for a species' establishment. Seasonal highs and lows, temperature extremes or averages, may be important factors which either permit or do not permit establishment of a species. The fluctuation between seasons may also be an important factor. While some species do not require a dormant period and can produce multiple generations in a year, others require a period of dormancy in order to complete their life cycle.

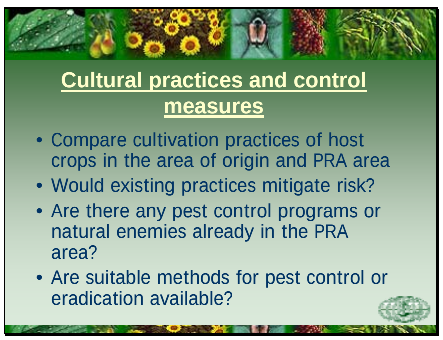
Slide 12



Climate, however, is just one of the environmental factors that might influence a pest's establishment. Here we have listed a few others, as examples. Soil type, drainage and other hydrological characteristics, vegetation, and other environmental factors will influence a species' success in any area. Each species presents a unique case, however, so developing a standard list of factors that must be considered in assessing probability of establishment is not feasible nor practical.

Keep in mind, too, that it may not always be possible to obtain information on many of these factors. Judgement and common sense will be necessary to determine on a case-by-case basis which factors are important and worth the effort required to obtain detailed information and which are not. Remember, that the better your knowledge and understanding of the species' biology, the conditions under which it occurs in its current distribution, and those in the PRA area, the better able you will be to assess its establishment potential.

Slide 13



Natural factors are not the only factors which influence a species' establishment. Man-made influences, including the cultural practices and control measures which are undertaken in the PRA area, will have a heavy influence, especially for pests in agricultural or landscape settings.

Information on the cultivation practices in the area of origin may be available from the exporting country's NPPO. These can be compared with practices in the PRA area to determine if significant differences exist which might influence the pest's establishment. For example, are apple trees pruned at a different time or year, are different cultivars grown, is fruit bagging a regular practice?

Would existing practices, activities that growers are already having to undertake to control other pests in the endangered area, also control the pest for which a PRA is being undertaken? Or would additional control measures be necessary? Are pest control practices undertaken? Are potential natural enemies present?

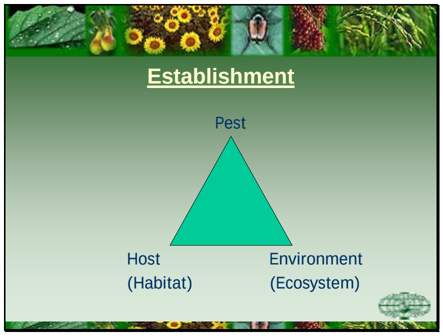
If existing practices will control the pest, then it may never become established, even if entry occurs.

If existing measures will not control the pest, are there suitable methods available which would control it?

Slide 14

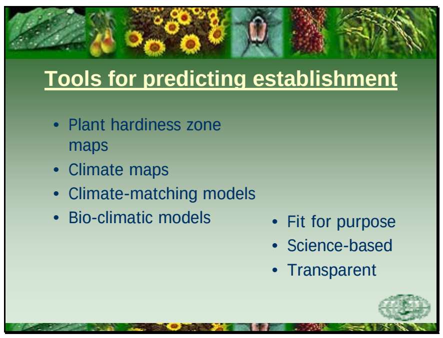
And the pest's biology will obviously have an important influence. Some pests are just better at becoming established after entry to new areas than others. Think about the reproductive strategies and the methods of surviving adverse conditions that are available to the pest. Plants that are self-crossing, for example, can produce fertile seed from a single plant, while plants that are not require more than one plant to produce seed. Some insects and molluscs and some fungi have likewise complex biologies which make establishment following entry more or less likely. Consider things like the duration of the life cycle and the number of generations per year that can potentially be produced. Think about the species' genetic adaptability, the minimum population size required for successful establishment, and other biological factors in assessing establishment potential.

Slide 15



Remember the triangle. We've said that establishment requires the interaction of the pest, its hosts and its environment, and we've collected information now on all three elements. The challenge is to combine this diversity of information, into a single assessment of the probability of establishment.

Slide 16

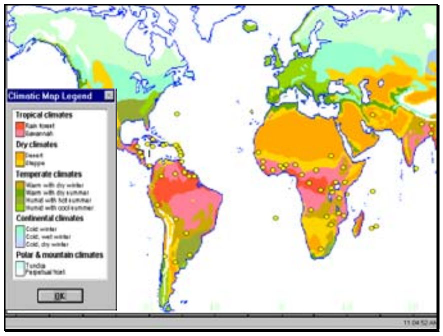


There are many tools that are available for helping to pull together all the information that has been gathered in order to predict establishment. These tools range from very simple ones, such as plant hardiness or climate maps, to highly complex computerized models that require a lot of data or calculated many thousands of iterations to estimate probabilities.

Selecting the tools that you will use will depend on a number of factors, including of course your own circumstances, your access to information and tools, the urgency of the situation, and the potential sensitivity of the issue. Whatever the method you select to use to assess potential establishment, it should be:

Fit for purpose – it should not be more complicated, more costly and more time-consuming than is necessary to make a decision, for example
Science-based – as for all parts of a PRA, the assessment of establishment potential should be based on science, on factual information and reasonable, justifiable assumptions
And it should be transparent – the PRA should include an explanation of the information that was used and the reasons for any conclusions that were reached regarding a pest's potential establishment. We'll look now at a few examples of tools that have been used to predict establishment of pests for the purposes of PRA.

Slide 17



The most straightforward and usual way of assessing suitability of environments is simple climate matching. This involves plotting the known distribution of a pest on a climate map, and judging whether similar conditions occur in the PRA area. It is very low-tech and requires only a map showing climate zones (or ecoregions, or plant hardiness zones) and a pencil. Most atlases, for example, include maps showing world climate. Plant hardiness zones are often used in weed risk assessments and are available on the internet for many parts of the world. Programs like the CABI Crop Pest Compendium will actually generate maps of pest distributions, overlaid on world climate.

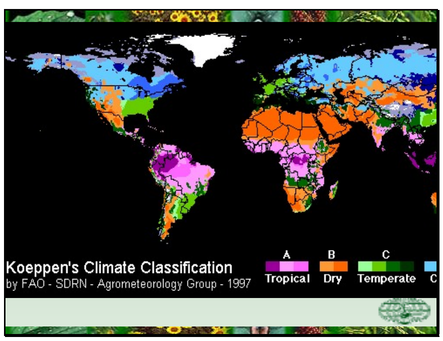
Here we have a world climate map taken from the CABI Crop Protection Compendium on-line. Similar climate maps can be found at several web-sites and in print atlases. Different maps use slightly different climate classification systems, but on the whole, they divide the world up into general climatic zones taking into account temperature, humidity, moisture and other significant climatic factors. In this map, the world is divided into 4 major climate zones – tropical, temperate, continental and polar or mountain climates, and each of these is further sub-divided. This map gives a simple visual image of the world's climate zones. By comparing the climate in the area where a pest is known to occur, either naturally or following its introduction there, and the climate in the PRA area, an analyst is in a position to make judgements about the likelihood of establishment.

This map shows the distribution of the tropical citrus aphid overlaid on world climate. The map shows that the tropical citrus aphid (as its name suggests) occurs primarily in tropical climates – those coloured pink or red on this map. In fact, its distribution lies almost entirely between the tropics of Capricorn and Cancer. In this case, it would appear that Europe and the Middle East, where the climate zone is marked in shades of green or orange, are unlikely to be at risk from this pest, as they do not have suitable climates.

This is a relatively quick and simple means of assessing probability of establishment, with pros and cons associated with it. Its pros include its speed and transparency – it is rapid, the maps are available relatively cheaply and widely; it is also easy to demonstrate what data was used – in this case, the yellow dots show the distribution information that was used to reach a conclusion – and explain the reasons for the conclusions.

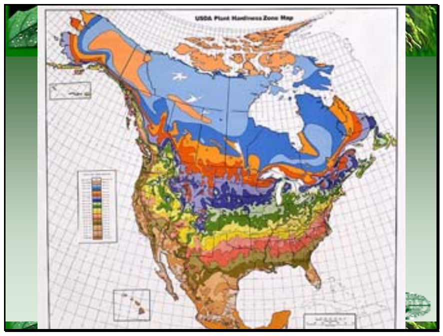
On the other hand, its cons include the fact that it is a pretty crude model and does not take into account climatic variations at the local level. With this system, it is not possible to detect micro-climates or local area factors either associated with the current distribution of the pest, or with the PRA area, that might influence the pest's future distribution in the PRA area.

Slide 18



The Koeppen Climate Classification system, available on the internet and in atlases, divides the world into five major climate zones – tropical, dry, temperate, cold and polar, each with 2 to 3 sub-zones.

Slide 19

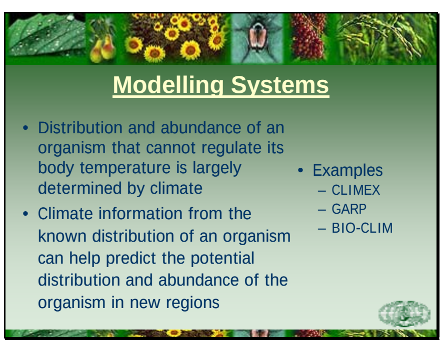


Here we have the USDA plant hardiness zone map for North America, also available on the internet and in print-form. Plant hardiness zone maps typically divide a geographical area into zones based on stress factors which limit the ability of plants to survive out-of-doors. In this case, the most significant factor was identified as winter low temperatures, so the area is divided into 10 zones based on average annual minimum temperature over a 30 year period. Other plant hardiness zone maps for other regions may be based on soil moisture, precipitation or high summer temperatures.

Maps such as these can be helpful in assessing potential distribution in just the same way that climate maps can be used as they provide a quick and consistent means by which to compare climate in two or more areas.

The important thing to note when using any of these maps, either world climate maps, plant hardiness zone maps or others, is to know and understand the data that has gone into defining the zones that are shown. There is no point in using this map, for instance as a tool to predict the distribution of a pest whose distribution is not limited nor aided by low winter temperatures. If a pest's distribution, however, is limited by cold temperatures, then this might be the perfect tool.

Slide 20



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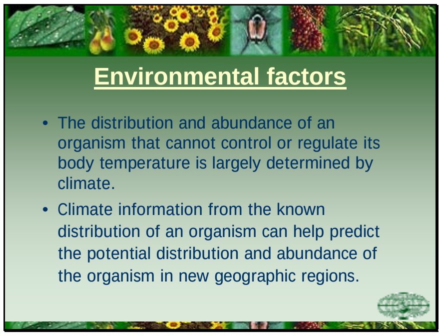
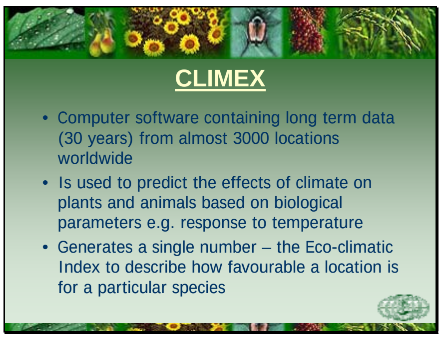


The suitability of the environment, or climatic suitability, of the PRA area is one of the most important factors in determining the potential distribution of a pest. Information about the climate and environmental conditions in the known distribution of the pest are often extrapolated to predict its potential distribution in the PRA area.

Slide 22



Other more sophisticated modeling systems exist for predicting pest distributions.

One of the most widely used of these is CLIMEX, a software program that predicts the potential distribution of species based on climate and biological parameters. The program contains world climate data collected between 1930-1960 at almost 3000 locations around the world, and uses the known distribution of a given species to predict where else in the world it might occur.

CLIMEX and other such models work in one of two ways. It may predict potential distribution of a pest based on its current known distribution, or it may predict future distributions using data on select climate variables identified by the analyst as those that are of significance for the pest in question. In the case of CLIMEX, an eco-climatic index number is generated to describe the suitability of a particular location for the pest in question – where the climate is very much like that where the pest occurs, the index is high; where the climate is very different from that where the pest occurs, the index is very low.

Slide 23

Let's consider the example of Asian longhorn beetle (ALB) (*Anaplophora glabripennis*) where the PRA area is defined as the United Kingdom.

The pest is a native to China and a pest of poplar trees. It was reported to be causing damage to trees in New York City in the USA in the mid-1990's and was subsequently reported in Toronto, Canada.

Some of its hosts include species grown in the UK and Europe, and two related species *Anoplophora malasica* and *Anoplpohora chinensis* were already listed as EU quarantine pests and are pests of citrus. Many other hosts include: Apple, Elm, Horse Chestnut, Maple, Oak, Sycamore, Willow.

The UK decided to initiate a PRA.

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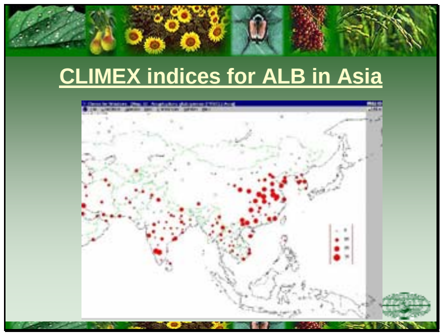
The dotted line delineates the outer limits of its distribution.

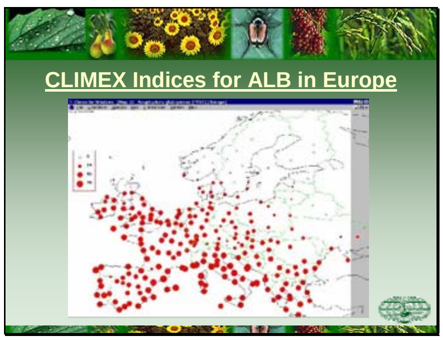
Slide 25



Data from the known distribution of ALB was entered into CLIMEX, which produced this map of potential distribution, or eco-climatic indices, for ALB in Asia. The eco-climatic index shows how favourable a particular area is for a given species. In this case, the larger red circles indicate more favourable areas, and the smaller red circles indicate possible, but less favourable, areas. We can see in this map that all of the sites where ALB is known t occur in China show up as large red dots.

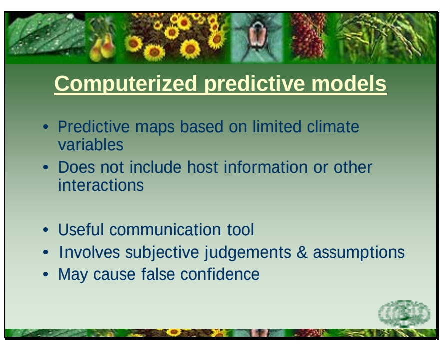
A similar model was generated for North America and large red dots appeared in the sites where the beetle had been found and was under official control.

Slide 26



Finally, the model was used to predict potential distribution of ALB in Europe, and showed that at least as far as climatic suitability, there is some cause for concern. Large to medium-sized red dots appeared throughout much of southern Europe including southern portions of the United Kingdom.

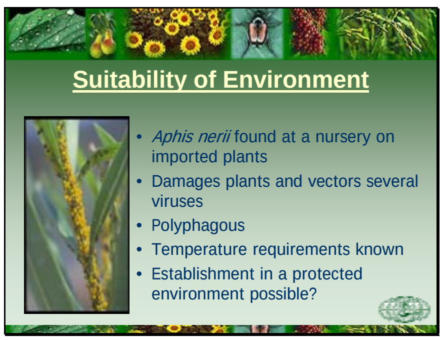
Slide 27



Overall, models such as CLIMEX are useful for generating predictive pest distribution maps based on climate suitability. The maps are good visual aids and communication tools and they allow the assessor to consider a range of scenarios in reaching his or her conclusions.

They do, however, have their drawbacks. They frequently do not include host information, and like simple climate-matching, they involve subjective judgements about the influences of different climate variables in the overall distribution of a species. Living organisms are complex and their establishment is influenced by the interaction of many variables; sometimes, these modelling systems are unable to account for this complexity and interaction of factors. And finally, the outputs of a computerized predictive model is sometimes so impressive and sophisticated that it is difficult for analysts or decision-makers to overlook the results, or to keep in mind, that behind the model there are many assumptions and perhaps not a lot of hard data. Models may sometimes be interpreted as being more accurate and reliable than they really are.

Slide 28

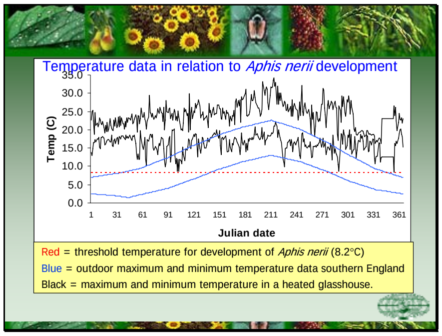


A final point under suitability of environments is the importance of considering the possibility of establishment in protected environments. Climate matching and climate modelling may be useful in evaluating outdoor conditions, but results may be meaningless if the pest can survive in a greenhouse or glasshouse.

An example that illustrates this is that of *Aphis nerii*, which was found in a UK nursery on imported plants. Two hosts that were present in the UK were beans (field crops) and sweet peppers (grown in glasshouses except for the warmest, driest part of the year). In this case, there was scientific literature that provided specific temperature requirements for the pest – its threshold for development is 8°C.

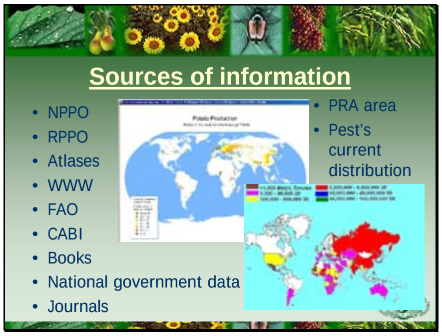
(*Aphis nerii* can transmit viruses, e.g. *Bean yellow mosaic virus, Cucumber mosaic virus, Watermelon mosaic virus*)

Slide 29



This graph shows temperature data in relation to *Aphis nerii* development. The red line is constant at 8°C and shows the pest's threshold temperature for development. The blue line shows the outdoor temperatures in southern England, with winter temperatures clearly falling below the pest's threshold. On the basis of this information, one might predict that *Aphis nerii* would be unable to survive winter in the UK and would therefore not be a persistent problem. However, the black lines show the temperatures found in heated glasshouses. These lines are clearly above the pest's threshold throughout the year, introducing the possibility that it could persist on sweet peppers in glasshouses during the winter, and be re-introduced to the field each summer, where it would also be able to infest beans.

Slide 30



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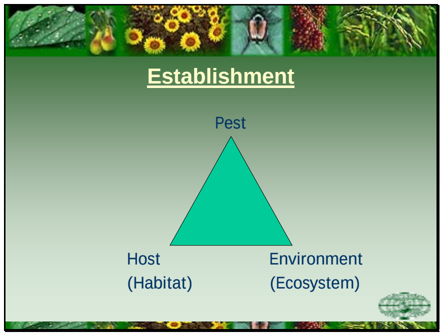
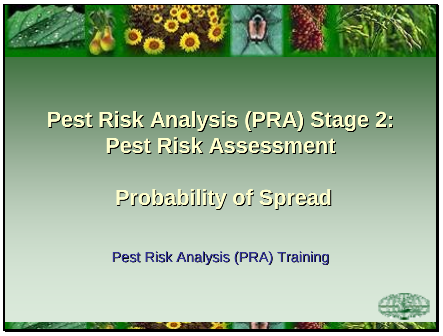


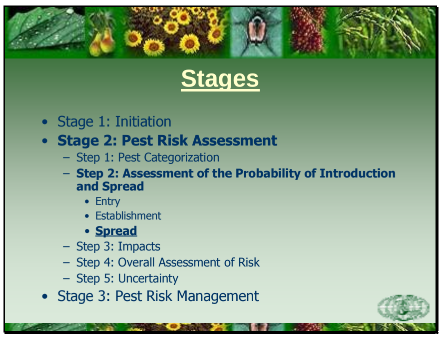
So, remember that evaluating the probability of establishment requires information and consideration of three principle factors – the pest, its host or habitat, and its environment. It's the interaction of these three elements which results in establishment, or the perpetuation of the species in the PRA area for the foreseeable future. Each individual species is a unique case and will be influenced by a unique set of variables, though the interaction demonstrated in this triangle remains constant.

Probability of Spread

Slide 1

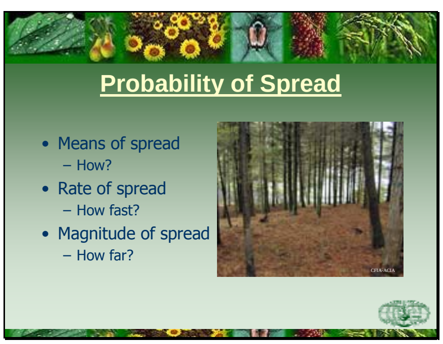


Slide 2



Once a pest has entered the PRA area and become established, it is necessary to assess probability of spread, as a next step in the PRA process.

Slide 3



Spread is a term that encompasses several parameters.

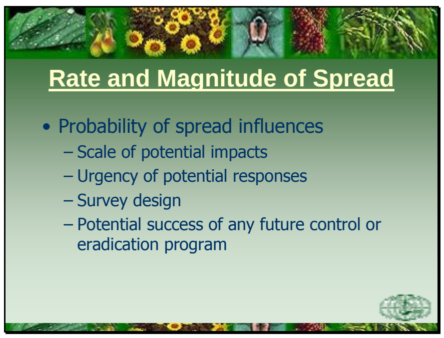
In assessing spread potential, a risk assessor must consider the species' means of spread – in what way does spread occur? How does the species move from one location to another? Does it fly? Crawl? Does the wind blow it? Or is it washed over distances by rainwater or streams? Is it carried by a vector? Are human activities an important factor in the spread of the species? These are all "means of spread".

The assessor must also consider that rate at which that spread occurs – is the pest a fast-moving species? does spread occur quickly? Slowly?

And, finally, we have to think about the magnitude of the expected spread – will the species ultimately travel a very long distance or will spread be restricted? How far will the pest actually spread if given enough time?

In assessing spread potential, its important that all three of these factors be considered and described in the PRA.

Slide 4



Why is spread important in a PRA? Why should we consider spread in a pest risk assessment?

Because the rate, distance and means of spread of a pest will greatly influence both the significance of the pest, if left unchecked, and the effectiveness of different management strategies which may be applied against it.

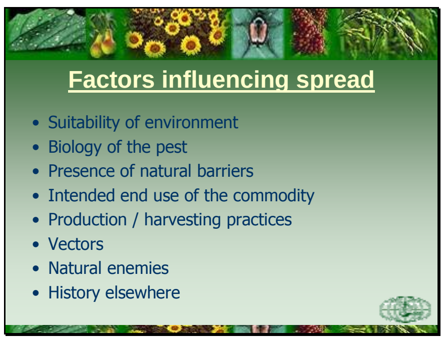
The rate and magnitude of spread that a pest is capable of will influence the magnitude of the impacts that might be experienced as a result

Rapid and wide spread which could result in a significant impacts will also necessitate a rapid response; spread therefore influences the urgency of any potential responses that might be introduced

And if surveys are necessary to delineate the distribution of a pest, information on its spread potential may contribute to survey design, but helping to identify priority survey sites

Finally, spread potential greatly influences the potential success of future control or eradication programs – different approaches are necessary for species that spread by different means, or at different rates. A pest that spreads quickly by uncontrollable means, such as wind or long distance flight, may require a different management strategy than a pest that is more sedentary - one that spreads very slowly or not at all, or something like a fruit tree viroid that spreads only as a result of vegetative propagation of host materials.

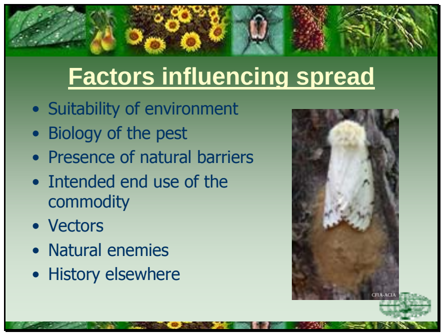
Slide 5



Just as spread influences other factors, like impact or response strategies, so is it influenced by outside factors. Assessing spread potential requires consideration of the pest's biology as it is understood in areas where the pest is already present, but this knowledge must be considered in the context of the PRA area. Environmental factors in the PRA area, such as climate, geography, host abundance or distribution, will contribute to the pest's potential to spread from the initial point of entry to other areas. Likewise, there may be natural physical barriers, things like mountain ranges, large bodies of water, or large tracts of land where no hosts are present, which may present obstacles to the pest's spread in the PRA area.

Human factors may also influence spread of the pests, either by enhancing or suppressing it. The human factors may include agricultural practices, harvesting or marketing practices, crop rotation or pest control strategies etc. The presence of natural enemies or vectors may likewise influence the rate, magnitude and ultimate scale of a new pest's spread within the PRA and should be considered in completing the pest risk assessment. Finally, historical records of the pest's spread following introduction elsewhere will also be very telling. If a species has successfully spread in other comparable areas where it has been introduced, it may be reasonable to expect a similar pattern.

Slide 6



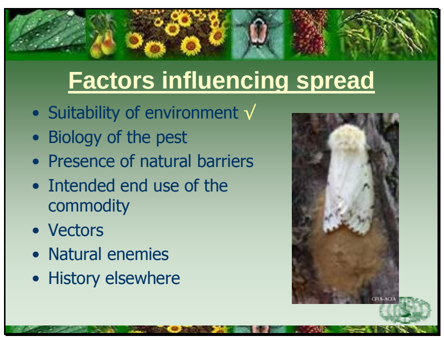
Note to presenter: this next series of slides can go very quickly, as they just add check-marks to each of the bullets that appear on this slide.

Points

Let's take the case of European gypsy moth, a Lymantrid native of hardwood forests over a wide area of Europe.

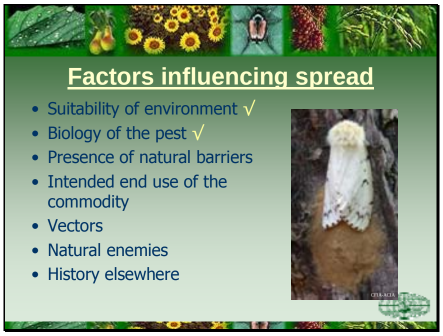
Gypsy moth was introduced into the northeastern United States in the mid-1800s. It is now present over much of the eastern half of North America, wherever suitable hosts occur. What are the factors that contributed to the spread that occurred? What can we learn from this experience that will help us predict the spread potential of other pests in other circumstances?

Slide 7



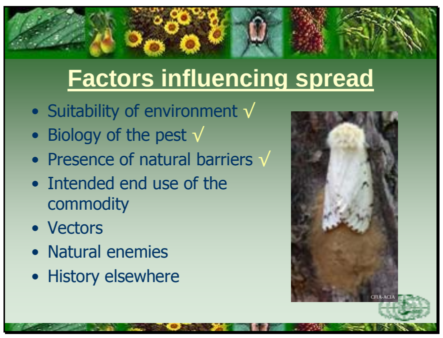
Well, the environment was certainly suitable. The mixed hardwood forests of eastern North America included many hosts that were either the same species as those present in the native range of gypsy moth, or were very closely related. Likewise, climatic factors were not greatly different in the species native range and in the area where it was introduced.

Slide 8



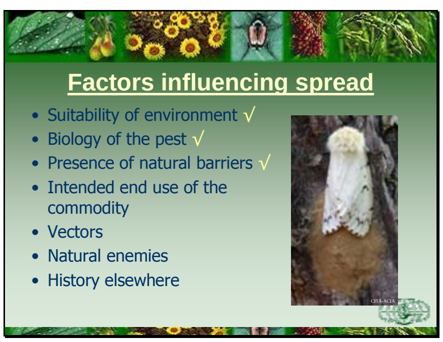
Biological factors also positively influenced gypsy moth spread. The female lays well-protected, hardy egg masses on the bark of host trees. The eggs are capable of surviving adverse winter conditions and the larvae emerged to find an abundance of suitable food. The moths do not fly long distances, but the large tracts of continuous forest, orchards and hedgerows in eastern North America provided corridors for its steady progression over long distances.

Slide 9



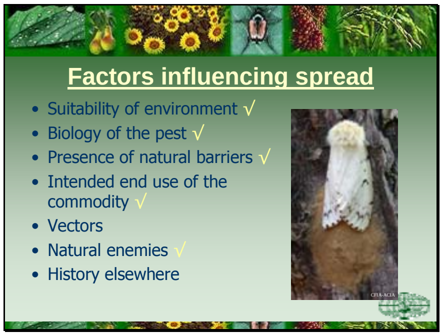
In eastern North America, few natural barriers exist and so there was no interruption to the moth's spread. Fortunately, in central North America, large tracts of grasslands, prairie and, in the west, mountain ranges restricted its progress across the continent. In the east, therefore, the absence of natural barriers contributed to spread, while in the west, the presence of natural barriers slowed the moth's spread.

Slide 10



Being an introduced species, there were few or no natural enemies present at the time of the moth's introduction. In the century and a half since gypsy moth was introduced to North America, natural enemies have been identified and introduced with positive results, but initially, these provided no protection and did not influence the moth's spread.

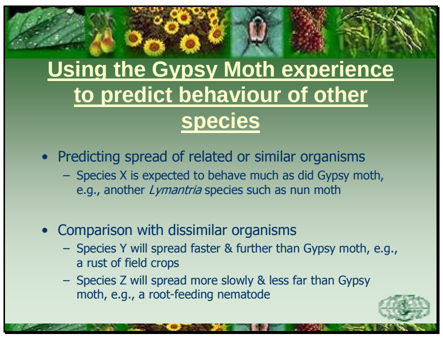
Slide 11



Hence, we can go down the list of factors which influence the spread of a new pest following its entry and establishment in a new area, and find that the situation in North America when gypsy moth first became established there was perfect for its steady progression across a very large area. Suitable climate, suitable hosts, no natural barriers, no natural enemies, did not require a vector.

Even the fact that egg masses lay on the bark of hardwood trees contributed to the ease with which it was spread. Logs, firewood and other wood products were harvested and moved about and carried with them live egg masses.

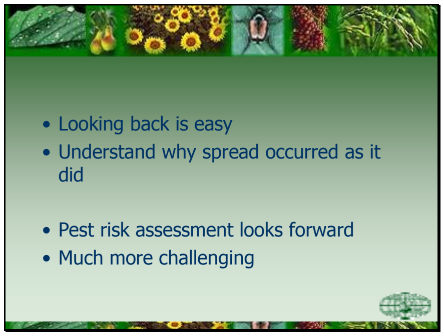
Slide 12



PRA is a comparative process – its about comparing different situations, different pests, commodities or pathways, and drawing conclusions about them and about what should be done in response to them. So, can we learn from the experience of gypsy moth's spread in North America to predict the spread of other species?

We can compare gypsy moth to other similar or closely related species, and predict their spread based on the history of gypsy moth. Nun moth, for example, is another European and Asian lymantriid with similar biology and host ranges. One might predict that it could spread in much the same way as did gypsy moth, if introduced in similar circumstances. Or we can compare gypsy moth to very different organisms and draw conclusions. A rust disease of field crops, for instance, is a very different organism. We might expect that differences in its biology or host range etc. might result in a very different rate and magnitude of spread. If it were introduced into a suitable environment, it might be expected to spread much further and faster than gypsy moth, whose spread was steady. On the other hand, we might conclude that a pest such as a root-feeding nematode will not spread nearly as fast, nor as far, as gypsy moth did, due again to differences in its biology and circumstances.

Slide 13



Looking back on the gypsy moth situation in North America it is easy to see why spread occurred as it did. Looking back, however, is easy. With the luxury of time and scientific data on a situation, we can study it and understand why things happened as they did.

Pest risk assessment, however, is a predictive tool. Its about looking forward and predicting what might happen in the future. This is a much more challenging task. For a scientist who works in facts and is accustomed to using scientific methods to prove hypotheses, predicting the future behaviour and effects of a pest in an area where it is not yet present, is a daunting task.

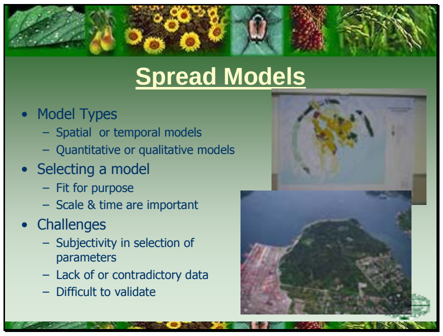
Slide 14

More and better tools are becoming available for predicting spread of pests.

We have discussed comparative analyses, using the example of gypsy moth, already. These types of assessments are very qualitative and make use of existing data and expert opinion to describe the predicted means, rate and magnitude of spread. They may describe spread in relative terms like “faster and further than” or “less effectively than”, or they may use descriptive terms such as “rapid”, “widespread”, or “localized”.

Predictive spread models are also sometimes employed to add more precision to the assessment of spread potential. These often substitute expert opinion or assumptions for hard data when that is not available. Predictive spread models may provide a visual image of spread over time, which is sometimes a very useful communication and planning tool.

Slide 15



Remember that we were to consider both the rate of spread and the overall magnitude of spread when we assess spread potential – how fast will spread occur? And how far will the pest spread? Temporal and spatial models provide illustrative means of predicting the answers to these two questions.

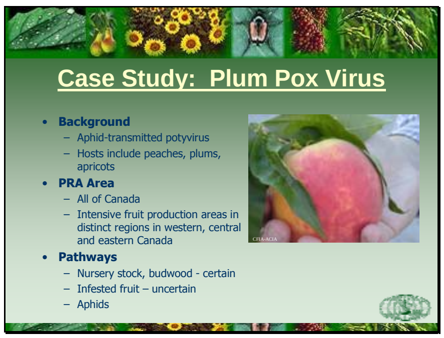
The photograph shows a forested area near a large international port. Brown spruce longhorned beetle was first introduced to North America at this port and became established in the adjacent forested area. The map above is a predictive model showing the expected spread of the beetle over time, with different colours illustrating the expected time frame over which the beetle is expected to spread over a wider area. This map is a useful tool for communicating risk to stakeholders, planning surveys or eradication actions, predicting costs of such actions, and defining a regulated area.

There is no single right model to use for predicting spread, however. There are a number of models available, and they range from very simple, qualitative or descriptive models, to highly complex and data-reliant mathematical algorithm-based models. The important point is that the model that is selected is fit for its intended purpose and appropriate to the issue at hand. A complex, highly technical model was selected in the example given due to the complexity and uncertainty in the situation. In other instances, where there is a low degree of uncertainty, or the issue is not highly complicated, a simpler approach may be perfectly suited.

The use of models such as the one in this example may present many advantages, but they also present challenges and these should be kept in mind when considering which model, if any, to select for use. While the ultimate map that is produced may appear to be very scientific and accurate, behind it there lie the same subjectivity and uncertainty upon which a qualitative description of risk would also be based. Selecting the parameters that will be incorporated into the model is a subjective process which requires expert opinion. Data may be lacking, contradictory or unreliable. And the model that is produced may be very difficult to validate. Minor changes in the parameters that are used, or the values that are assigned to those parameters may result in very different models.

It is important when using models to fully understand and explain the parameters that have been used to develop it, and the limitations or uncertainties that lie behind it.

Slide 16



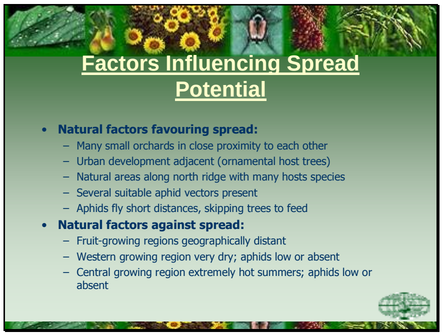
Let us look at another case study – this time an aphid-borne virus that affects stone fruits in the genus Prunus.

Plum pox virus is a potyvirus, it is spread by aphids or by vegetative propagation of fruit trees & ornamental Prunus. Important economic hosts include peaches, plums and apricots.

A PRA was conducted in Canada, which identified the PRA area as all of Canada – a country where intensive fruit production occurs in three distinct and widely separated areas in the west, centre and east of the country.

The identified pathways certainly included nursery stock and budwood, though fruit was possibly another pathway, and aphids, of course.

Slide 17

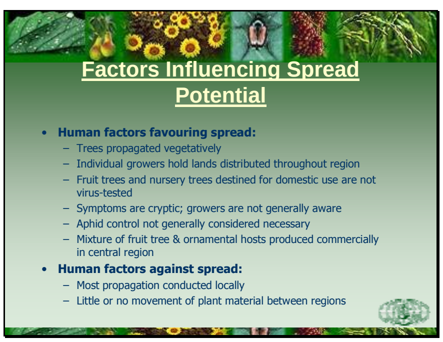


In assessing the spread potential of plum pox virus, the assessment considered natural factors which both <u>favoured</u> and <u>interfered with</u> spread.

There were lots of favourable factors which could contribute to spread – within the production areas, orchards are very close together, and are adjacent to urban areas where ornamental flowering *Prunus* are popular garden plants; furthermore, there are numerous native wild *Prunus* species in adjacent wild areas close to the fruit production sites and several suitable aphid vectors are known to be present. Aphid behaviour also contributed to spread, as aphids normally feed intermittently and move about between trees, often flying over 2 or 3 trees before landing again to feed.

On the other hand, there were also natural factors which did not favour spread. The three distinct fruit-growing areas are far distant from each other, thousands of kilometres apart. In the west, the production area is in a very arid climate zone where aphid numbers are very low or aphids are not present. In the central region, the summers are extremely hot and again, aphid numbers decline markedly during this time.

Slide 18

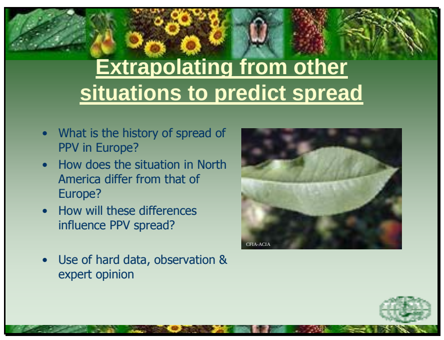


There are also human factors to consider in assessing spread potential.

In the case of plum pox virus, human factors that favoured spread were numerous. Orchard trees are commonly or exclusively propagated vegetatively, individual growers had holdings scattered throughout the production area and they moved material between their fields very liberally, there was no official virus-testing program available because the plants were not intended for export. The symptoms of infection are very cryptic, its difficult to identify infected plants and growers were generally unaware of plum pox, they had never heard of it and were not on the lookout for it. Aphids, though present, were rarely considered important enough to merit control, and within the same production area both fruit trees and flowering ornamental species are produced commercially.

On the other hand, most propagation was very local so there was little movement of plant material between the three distinct production areas.

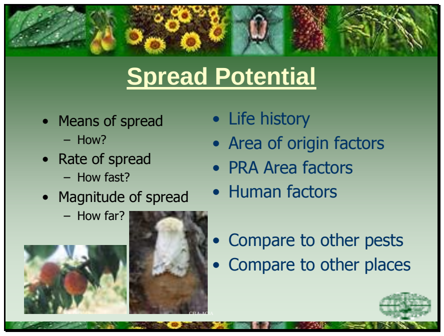
Slide 19



With these circumstances as background, the pest risk assessment considered the situation in other areas where plum pox occurs in order to assess the virus' spread potential in Canada.

Plum pox virus has been known in Europe for a considerable length of time and is well-studied. Reports of its first occurrence in different locations are recorded and mapped, so it was possible to compare the European situation with that in Canada. It was necessary, however, to compare the two locations carefully. Significant differences in climate, geographical factors, production practices and other factors influence spread in the two regions. By using hard data, observations and expert opinion, it was possible to compare the two locations and make judgements about the spread potential of plum pox in Canada, based on experience in Europe.

Slide 20



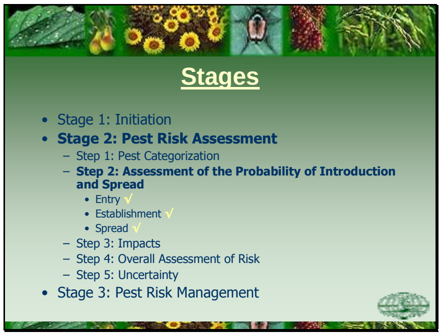
We've looked at two very different cases – gypsy moth and plum pox virus. In each instance we considered the same factors in determining reasons for historical spread or predicting future spread.

These two pests have very different means of spreading – plum pox virus is spread by unintentional long distance human transport of budwood or other propagative material & very local flight of infective aphids, while gypsy moth was distributed by means of short distance flight & localized human distribution of egg masses on logs, firewood or equipment.

And we observed very different end results – gypsy moth covered half a continent in less than a century; plum pox virus spread was limited by human and natural factors to a relatively restricted area.

The same basic principles, however, were applied to the assessment of the spread potential of each. Using knowledge of the pest's life history, factors in its area of origin and in the PRA area, and human factors, an assessment of a pest's spread potential is possible. Spread potential may be expressed in different way, including both qualitative or quantitative means, and may be made by comparison to other related pests or by comparison to other places where the pest has been introduced.

Slide 21

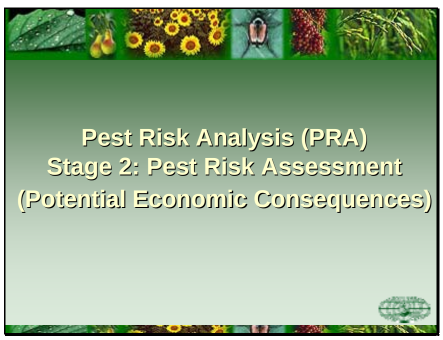


After assessing spread potential we have considered all of the three factors which contribute to the probability or likelihood part of the risk equation.

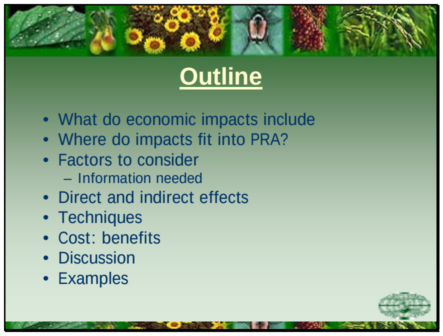
Introduction to Impacts and Assessment of Potential Economic Consequences

Slide 1

Slide 2



Slide 3



We'll begin with an outline of what we will discuss today. We'll talk about what economic impacts include, where do economic impacts fit into PRA, some factors that we need to consider, information needed, indirect and direct effects, techniques that can be used, cost/benefits, and perhaps we'll finish with a discussion and some examples.

Slide 4

So what do economic impacts include? Well, the scope of the IPPC applies to the protection of all flora, commercial, cultivated and wild. In the past it has been misinterpreted that the IPPC is only commercially focused, but this isn't true. The IPPC can account for environmental and social concerns with economic consequences and impacts of the PRA. An economic impact includes environmental and social impacts. Economic analysis can use a monetary value as a measure. Also, qualitative indicators are also acceptable: the pest caused high damage, it had a low impact. Those sorts of terms can be used to describe impacts. Environmental and social analyses that don't use monetary terms are also acceptable.

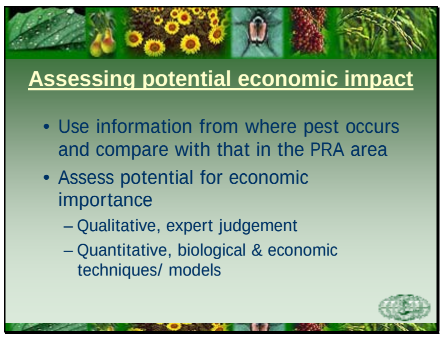
Slide 5

Where do impacts fit into the status of the PRA. We've seen this slide before. Pest categorization is where it is judged whether a pest fits the criteria of a regulated pest ie. a quarantine or regulated non-quarantine pest. For a quarantine pest the pest has to have potential economic importance so you are considering economics there in pest categorization. For a regulated non-quarantine pest it has to have economically unacceptable impact. Moving down into impacts, clearly you are assessing economic impact here but also in pest management when you are looking at the cost effectiveness of measures.

Slide 6

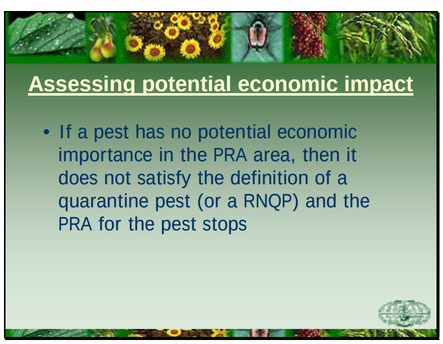
So how do we assess potential economic impact? Collect information for lots of parts of the PRA and to judge whether it is going to have an impact, look in the areas and other regions where the pest already occurs. When collecting that information it is important to note whether the pest causes major, minor or no damage, whether the pest causes damage, how often it does, infrequently or frequently and try to relate that information, using judgment to decide, to the conditions in the PRA area. Would it be similar, would they apply, and taking into account biotic and abiotic effects.

Slide 7



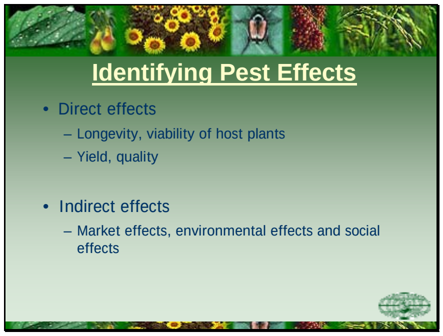
Using the information for where the pest occurs and compare that to the PRA area. Assessments about the impacts of the pest can be conducted using qualitative judgment, qualitative descriptions and expert judgment, or with more time and resources, models and spreadsheets.

Slide 8



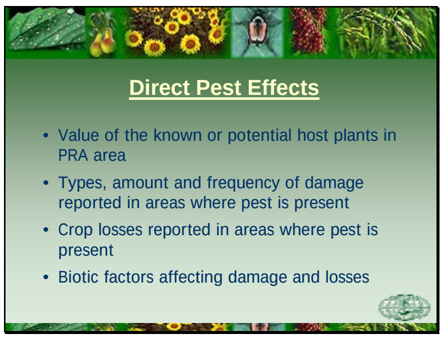
If a pest has no potential economic importance in the PRA area it doesn't satisfy the definition of a quarantine pest or a regulated non-quarantine pest and you can stop the PRA.

Slide 9



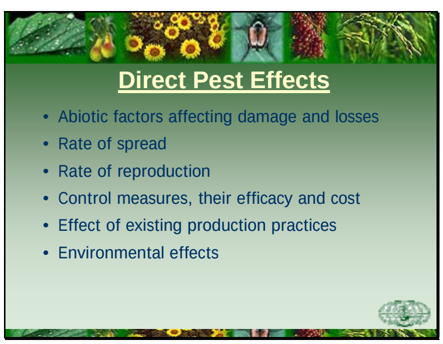
So what kinds of effects can a pest have? It can have direct effects, which are the initial immediate effects caused by the pest on the host and that will probably cause a loss in yield or a loss in quality.. Indirect effects are also another factor of describing impacts such as loss of habitat due to an invasive plant.

Slide 10



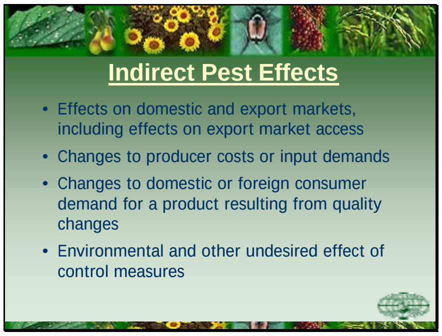
When assessing direct effects, if the value of the host plants or crop in the PRA area is known and a proportion that is damaged overseas is also known, that same proportion can be applied in the PRA area. The value that could potentially be lost can then be determined. Crop losses reported in areas where the pest is present can give an indication, if conditions would be the same in the PRA area. Those losses could be the same or perhaps more or perhaps less. Then figures can begin to be associated to potential damage.

Slide 11



There are abiotic factors affecting damage and losses such as the rate of spread of the organism, the rate of reproduction, control measures, what is currently being done against other pests, whether they work against the pest of concern, the effects on existing production practices and the environmental effects that might occur.

Slide 12



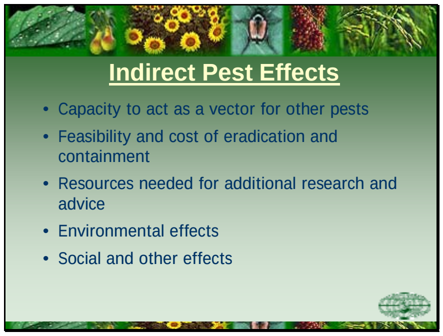
Indirect pest effects were mentioned before so let us now think about them. These are effects on domestic and export markets, which include effects of export market access. If export to another country is intended and the presence of the organism in the exporting country prevents that export, crop losses in yield and damage might not occur. However because it is a quarantine pest in another country it is preventing trade of that commodity to that country, so loses in market access are expected. That is an indirect pest effect.

There are changes to producer costs for growing and producing the crops if they have to apply new chemicals, conduct new measures, or require extra labour. Those are extra costs, or an indirect effect.

Perhaps there are some quality changes in the material being produced which effects demand. People may not want the product as much because it is not such a good quality, either in the producing country or where it is being imported. Although the importing country might accept it, there might not be such great demand and the price might go down.

Other effects include environmental and other undesirable effects of the control measures perhaps, pesticide spillage, effects on non-target organisms, those could also be impacts.

Slide 13



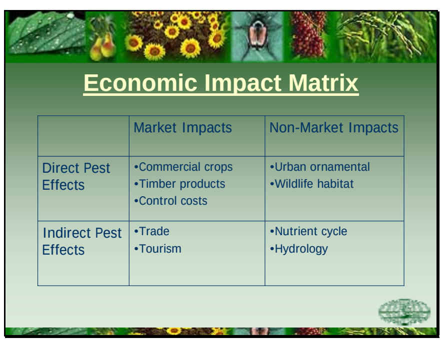
The pest may also affect other organisms. For example a *Thrips* or a whitefly and so on, might vector viruses, spread other pests, nematodes, or diseases and so on.

Considering feasibility and the cost of eradication and containment, that could be prohibitively expensive. Perhaps in the longer term it might be necessary to adapt to living with a pest.

Sometimes additional resources are needed to provide extension advice to farmers and growers and conduct additional research.

Environmental and social effects are also indirect pest effects. The potato blight in Ireland and the Irish potato famine where there was starvation and part of the population of Ireland moved to North America is an excellent example of a famous social effect. Another example, in India where they in the past grew coffee. A disease entered and established, wiping out the coffee plantations. The labour changed, and now tea is grown instead of coffee. That had social impacts.

Slide 14



Here we are looking at different types of economic impacts. There are direct and indirect effects on the left and market impacts and non-market impacts across the top. Market impacts are things that have a monetary value. A direct pest effect with a market impact is effects on commercial crops, apples, oranges, potatoes and so on. They could have reduced yield or quality as a result of a pest, so there would be financial loss to the grower. Timber products could have a reduced yield, or extra control costs might be required. These market impacts can be measured in financial terms. A unit monetary impact could be applied to them.

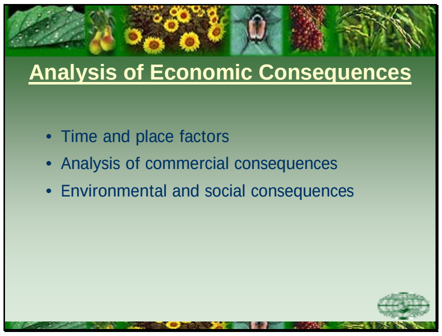
Similarly, indirect pest effects where trade or tourism might be impacted. Those are market impact that can be measured in financial terms. So, if a disease that kills trees in a forest area that attracts tourists establishes, less tourists visit and spend less money in staying in hotels and eating in restaurants. The area is not as attractive to them because there are less or no trees left. Many have been killed by the disease. The loss in income for that area because of lack of tourists is a market impact. It's an indirect effect of the pest.

The non-market impacts are more difficult to describe and more difficult to quantify. A direct pest effect of a disease that kills trees in an urban environment with trees lining streets might have non-market impacts. Trees in cities absorb pollution, so removing the trees might increase pollution, which might impact on human health. Wildlife habitat might become reduced because the trees or shrubs that are destroyed are the right habitat to other wildlife. If the host is removed then the wildlife loses its habitat. This is a non-market impact. People don't sell and buy wildlife, but they like to see it and they like to know its presence - so it has an impact.

Indirect non-market impacts are even more difficult to understand. An example of indirect, non-market impacts are effect on the nutrient cycle. Different plants in a community can become affected, then the C and N cycle could be affected. Equally, the hydrology, the water in the soil, might be affected. The drainage becomes affected and increased flooding and so on might occur because of the change in the flora by pests that come in and cause death of damage of plants.

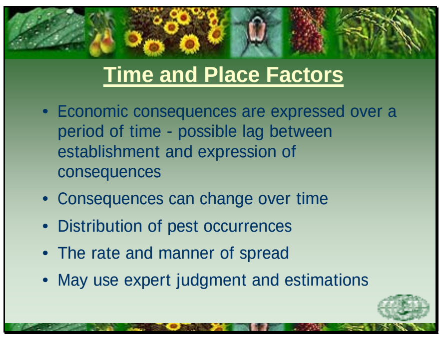
[NOTE - some people might consider control costs as indirect while others call them direct pest effects but in the end it doesn't really matter because you are considering all the impacts together.]

Slide 15



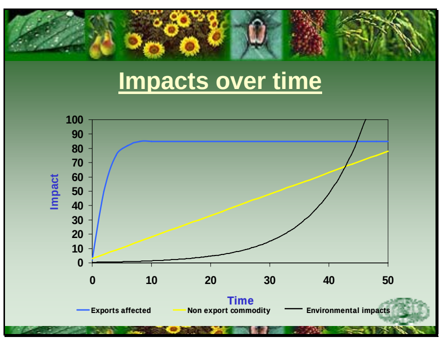
ISPM No. 11 suggests the things to consider when analysing economic impacts. Consider time and place factors, analysis of commercial consequences and also environmental and social consequences.

Slide 16



Economic consequences are expressed over a period of time. There may be a time lag between establishment and expression of consequences and the consequences can change over time. The distribution of pest occurrences change, if it is just a single point and spreads slowly, or if it is introduced at multiple points and spreads very rapidly. Where the pest is and the time it takes to cause impacts should be considered. Those are factors that need to be considered. The rate of spread and the expected manner of spread are also important. Expert judgment and estimations can help contribute to the analysis.

Slide 17



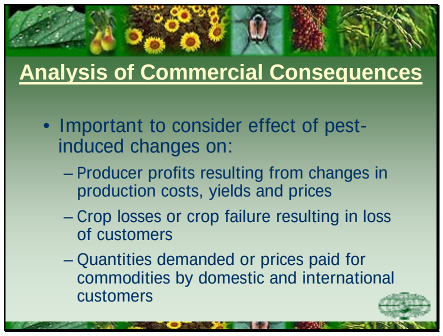
Here is a graph of impacts over time. We'll take a little time to explain the graph. Time is along the x-axis. This could be years for example. Some measure of impact along the y-axis. The blue line increases suddenly up to about 80 within ten years and then crosses horizontally. It represents a commercial crop that is exported where the presence of an organism causes export bans which is a very rapid response by other nations to prevent the exporting country selling its goods internationally. The impact is very dramatic and very quick. It is a very steep rise and then once that ban is in place, it stays in place and the line is horizontal until something changes. Until the pest is eradicated and the other countries then reinstate trade and allow trade, then the line would come down. But as you can see here the line stays horizontal.

In contrast, the yellow line, which is a smooth diagonal line from the bottom right to the top left, represents a commodity that is fairly homogeneously distributed across the landscape. The pest arrives at a single point and spreads out slowly each year causing the same amount of damage each year. A steady increase in damage over time as it spreads slowly.

The bottom black line which goes along at a very low impact and then a dramatic rise over time so that over time it has the biggest impact of all. That might be an example of an environmental impact where an organism comes into a country spreading, is insidious, doesn't really seem to have an impact and then perhaps it's clogging up water ways and people hadn't realized that and over time fish are suddenly dying, tourists aren't visiting the areas or people are walking on what appear to be solid ground but is actually some plant that has covered the surface of the water and people are drowning. All sorts of trouble, loss of wildlife and things. Those environmental impacts all gather together and in the longer term it might have the biggest consequences.

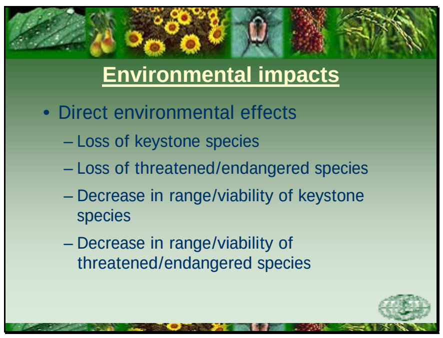
This is just a theoretical graph but it helps demonstrate in different ways about different types of impacts and when they happen and depending on the host.

Slide 18



It is important to consider the effect of the pest on producer profits resulting in changes in costs or yields or prices. Crop losses or crop failure need to be considered and perhaps quantities demanded and prices paid for commodities by international and domestic customers. This is about supply and demand.

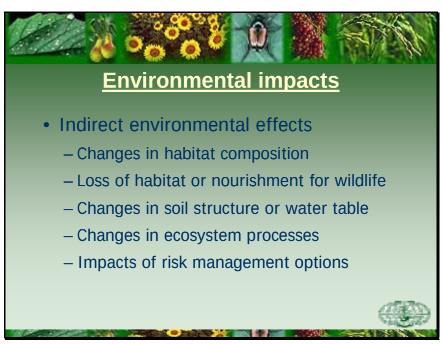
Slide 19



Environmental impacts can include direct effects such as loss of keystone species, which are species that are of fundamental importance to the integrity of the ecosystem. An example of this was chestnut blight which spread rapidly through the forests of the USA from Maine to Georgia destroying chestnut trees and subsequently causing tremendous economic and ecological disruption throughout the Appalachian forests.

Other direct environmental effects include loss of threatened or endangered species, and reduction of range or viability of keystone species or endangered species.

Slide 20



Indirect environmental effects include
Changes in habitat composition
Loss of habitat or nourishment for wildlife
Changes in soil structure or water table
Changes in ecosystem processes
Impacts of risk management options – such as introduction of exotic biocontrol agents or pesticide application

For example a pest that kills large expanses of trees may result in increases in dry standing timber and an increase in risk of catastrophic wildfire

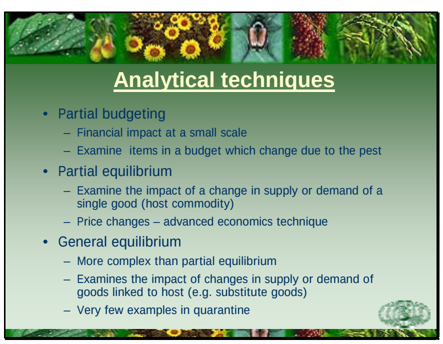
Slide 21

Slide 22

Social effects can include:

Loss of employment – for example loss of forestry jobs due to death of trees or wildfire
Migration
Reduction in property values – urban landscaping with trees and shrubs increases property values and those values decrease if the trees all die
Loss of tourism – an aquatic invasive plant may choke swimming or boating areas making them unsuitable for swimming or boating
Reduction or loss of availability of traditional plants for cultural purposes
Human health risks – some pets of plants produce allergens which cause human health impacts

Slide 23



ISPM No. 11 gives general guidance on three analytical techniques that may be used to assess impacts.

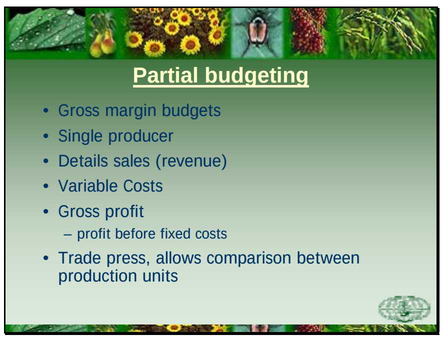
Partial budgeting looks at the financial impacts on a small scale and it looks at the items in a budget which change due to the pest.

Partial equilibrium examines the impact of the pest on the change in the supply or demand of a single good. It is likely going to look at the national economy and it looks at the host and it looks at price changes. It is quite an advanced economic technique. Normal biologists doing PRAs would not be able to do this – they would have to consult an economist to do this kind of work. This technique is not that widely used in PRA.

General equilibrium is a more complex analysis. It is really complex to do this, very few economists can actually do it themselves. It looks at the impact of changes in supply and demand of other goods linked to the host – other subsidiary things that link to it. This is very rarely used – there are only a few examples of this in quarantine at all. And there is hardly any at all in plant health. Sometimes it has been used in animal health.

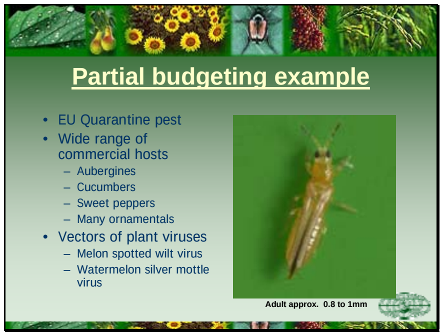
For this course we will talk only about partial budgeting.

Slide 24



The most commonly used and the simplest technique that we could use is partial budgeting. This is basically arithmetic. This uses cross margin budgets which are used by industries to compare different grower's production facilities for example. It might be available in trade press. So there is a magazine in Britain called 'Farmers Weekly' and it might give features on different farmers each week. It might describe a gross margin, a measure of the efficiency of the farmer. How much he spends growing his crop and how much profit he makes. Gross margin budgets relate to a single producer and it provides details of the revenue and variable costs. It provides a gross profit, which is the profit before fixed costs are taken into account. The gross margin budgets are used by industry for a comparison between different units.

Slide 25



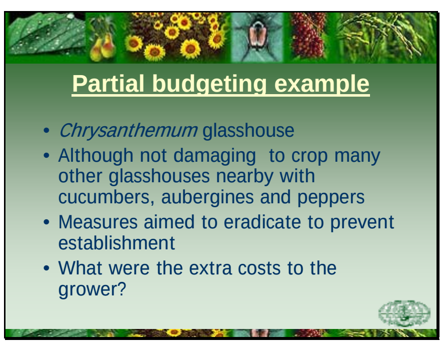
Now we will demonstrate partial budgeting with an example.

Thrips palmi is an EU quarantine pest. It has a wide range of commercial hosts – aubergines, cucumbers, sweet peppers, ornamental plants, and it vectors a couple of viruses. It has been found in tropical regions but also into northern Asia into Japan and Korea. A number of interceptions have occurred in Europe.

Slide 26

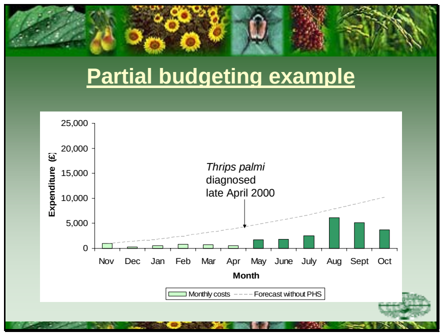
A risk assessment was conducted that showed it could establish in glasshouses in northern Europe. There has been previous outbreaks in Dutch glasshouses in the Netherlands.

Slide 27



The first UK outbreak was in a *Chrysanthemum* glasshouse. Though it was not damaging to the *Chrysanthemum* plants, nearby there were growers that were growing aubergines, cucumbers and peppers. Authorities were worried that the *Thrips* might get to those glasshouses where they would cause damage. Measures were put in place to eradicate the *Thrips* from the glasshouse with the flowers. During the eradication the opportunity was taken to measure the extra costs and what they were to the grower.

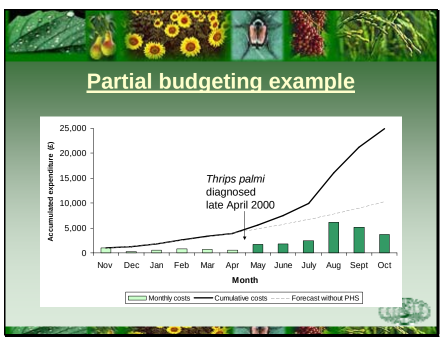
Slide 28



The cost of invertebrate pest management was estimated in one glasshouse at the *Thrips* palmi outbreak site over one year. So this graph shows the months of the year on the bottom, when the outbreak was occurring, and the expenditure on control along the y-axis.

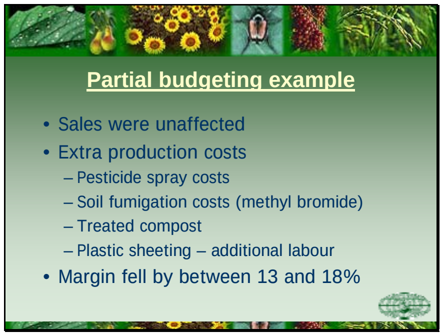
The bars show the monthly costs and the dotted line shows cumulative costs between November and April and then projects forward on to October. *Thrips palmi* were diagnosed in late April by the Plant Health Service in the UK and they stepped in and changed the management regime and put in new measures. This resulted in extra control costs. The darker colour green bars show what the control costs were, determined by recording the amount and frequency of chemical control - what was applied, how much it cost, and so on,

Slide 29



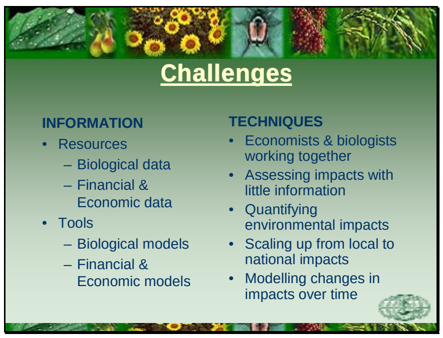
The solid black line shows what the control costs were. Instead of the dotted line extending to the typical expenditure for this glasshouse, because of the eradication campaign, it jumped to about 2 and a half times the amount of normal pest control costs but that did result in the eradication of the *Thrips*.

Slide 30



We could use that information in a partial budget to see how it impacted the producers' profits. Sales were not affected, but there were extra production costs, extra costs of control, extra spray costs. There was soil fumigation in the beds that the flowers were grown in – methyl bromide was applied. They had specially treated compost, plastic sheeting placed over the soil to prevent the larvae from getting into the soil to pupate, and additional labour costs. The margins fell by between 13 and 18 %.

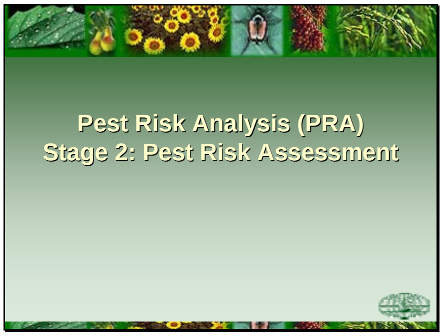
Slide 31



There are challenges to conducting economic impact assessments in PRA. A great deal of work is still being done in this area.

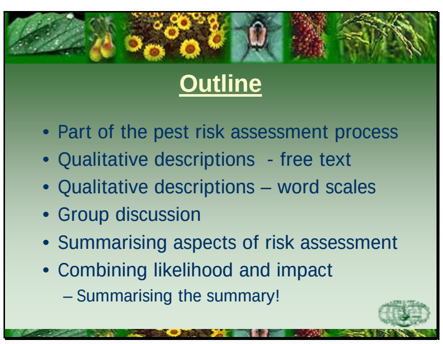
Overall Assessment of Risk

Slide 1



Slide 2

Slide 3

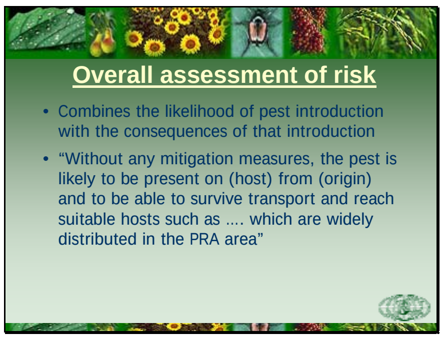


We will begin again with an outline saying how assessment of risk is part of the analysis process. We will describe risk in qualitative manner using free text, sentences, and normal words. We could also describe it qualitatively by using defined words and a scale. We will talk about summarizing risk assessment and combining likelihood and impact which is essentially summarizing the summary.

Slide 4

So combining assessment of likelihood with impacts is in Step 4 of pest risk assessment and the overall assessment of risk.

Slide 5

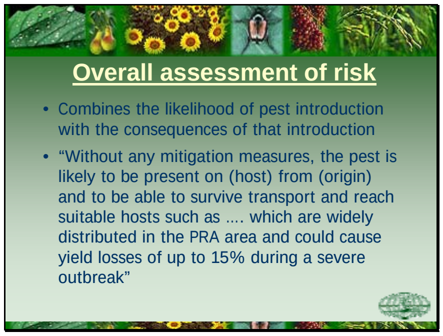


In an overall assessment of risk combining the likelihood of pest introduction with the consequences of that introduction without any mitigation measures is needed. Here's an example and think about whether this is a good overall assessment of risk.

At the end of a risk assessment it was written – "without any mitigation measures the pest is likely to be present on ____ (whatever host) from ___ (whatever country) and be able to survive transport and reach suitable hosts such as ___ (whatever the hosts are) which are widely distributed in the PRA area".

Is this a good assessment of the risk? Look at the words, the information provided. Is that a good assessment of the risk? It's talking about the pathway, the host, where they're from, surviving transport, and it comes to some sort of conclusion that it is likely to be present and so on and hosts are widely distributed. It's about likelihood. It doesn't say anything about impacts – remember risk is a combination of likelihood and impact.

Slide 6



So the next part of the slide improves that sentence – it goes on …which are widely distributed in the PRA area and could cause yield losses of up to 15% during a severe outbreak. This last part describes impact. The first part was just likelihood – it wasn't an assessment of risk. Risk is likelihood and impact so both the first and second part are essential to actually make a risk assessment.

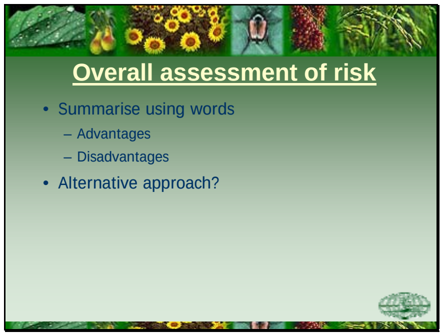
Slide 7

Here's another example – although a pest can spread (remember introduction is entry and establishment from foreign countries) impacts are very low. What do we think of that? How can it be improved?

Slide 8

A key point to note here is the word 'can' (which has no measure of likelihood). 'Can' can have a 1% likelihood or a 99% likelihood so it is essential to provide more specific information. The first phrase could be improved by words such as 'very likely' - you need to have an assessment of the likelihood. The impacts were given – so that part is okay.

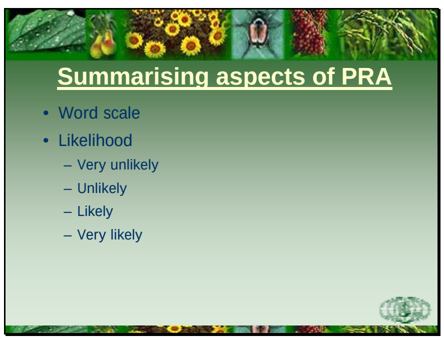
Slide 9



Here's an exercise for the class. Split into two groups and have a volunteer from each, come up to the front [whiteboard, blackboard etc] and class members should call out what the advantages of using words might be.

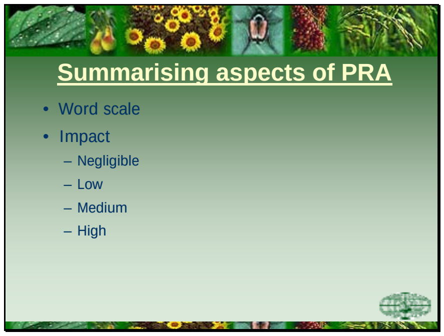
[Hopefully there will be things like:
1) when people commonly speak to each other they use words
2) probably what is most commonly reported in literature
Then move on to the disadvantages:
1) could be misinterpreted
2) could be received as less scientific
If this exercise takes place about half way through the week the students should come up with some good answers for these. What you are trying to do is to get them to say it is okay to use words but to find have a defined scale.]

Slide 10



Words for likelihood could be: very unlikely, unlikely, likely, very likely.

Slide 11



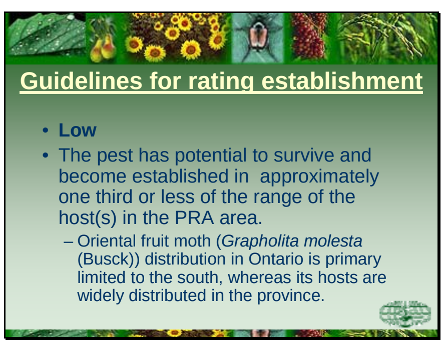
Words for impact scales could be: negligible, low, medium, high.

Slide 12

Some guidelines for rating establishment are described here. Negligible means the pest has no potential to survive and become established in the PRA area.

For example...Stewart's wilt of corn (*Erwinia stewartii* (Smith) Dye) distribution is limited by the overwintering capabilities of its insect vector, the corn flea beetle (*Chaetocnema pulicaria* Melsheimer). In most years, winter temperatures throughout Canada's corn-growing regions are too low to allow survival of the insect-vector, in which the bacterium could overwinter.

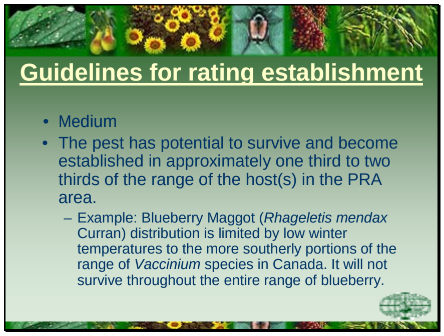
Slide 13



Low means the pest has potential to survive and become established in approximately one third or less of the range of the host(s) in the PRA area.

For example...Oriental fruit moth (*Grapholita molesta* (Busck)) distribution in Ontario is primary limited to the south, whereas its hosts are widely distributed in the province.

Slide 14



Medium means the pest has potential to survive and become established in approximately one third to two thirds of the range of the host(s) in the PRA area.

For example...Blueberry Maggot (*Rhageletis mendax* Curran) distribution is limited by low winter temperatures to the more southerly portions of the range of *Vaccinium* species in Canada. It will not survive throughout the entire range of blueberry.

Slide 15

High means that the pest has the potential to survive and become established throughout most or all of the range of hosts in PRA area.

For example...Current Old World distribution of Cherry Ermine Moth (*Yponomeuta padellus* (L.)) suggests that the pest could become established in North America wherever its hosts are found.

Slide 16

This is from a Canadian PRA: Negligible means that the pest has no potential to survive and become established in the PRA area. So explaining what the word means in a biological context helps others who are doing this work and risk assessments to understand how the word is to be used and what its rating is.

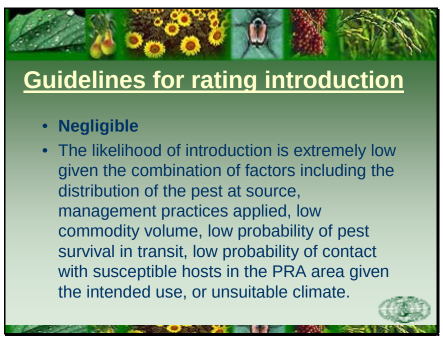
Low means the pest has potential to survive and become established in approximately 1/3 or less of the range of the hosts in the PRA area.

Medium means the pest has potential to survive and become established in approximately 1/3 to 2/3 of the range of the hosts in the PRA area.

High means the pest has potential to

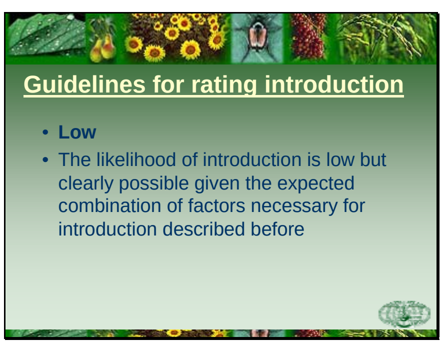
survive and become established throughout most or all of the range of the hosts in the PRA area.

Slide 17



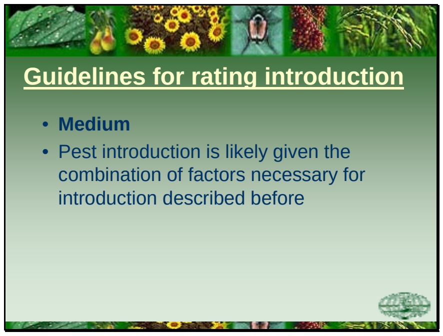
Guidelines for rating introduction
Negligible means the likelihood of introduction is extremely low given the combination of factors including the distribution of the pest at source, management practices applied, low commodity volume, low probability of pest survival in transit, low probability of contact with susceptible hosts in the PRA area given the intended use, or unsuitable climate.

Slide 18



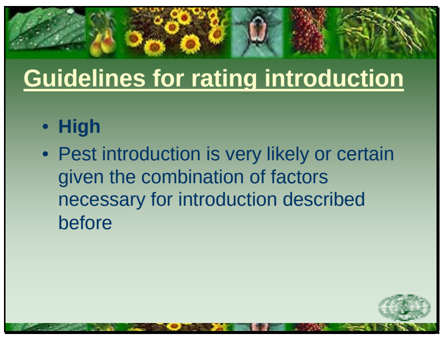
Low means the likelihood of introduction is low but clearly possible given the expected combination of factors necessary for introduction described before.

Slide 19



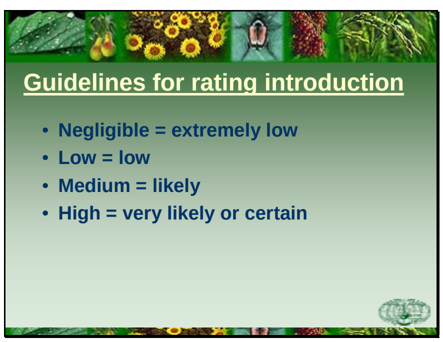
Medium means the pest introduction is likely given the combination of factors necessary for introduction described before

Slide 20



High means the pest introduction is very likely or certain given the combination of factors necessary for introduction described before

Slide 21



Negligible describes an extremely low likelihood of introduction
Low is a low likelihood of introduction
Medium indicates a likely introduction
High indicates a very likely or certain introduction

Slide 22

Some guidelines for rating impact
Negligible means that there is no impact on yield, host longevity, production costs or storage.

For example...Septoria leaf spot (*Septoria ampelina* Berk. and Curtis) infection results in leaf drop in grape that is premature by a few days only, with no treatment necessary and no economic losses.

Slide 23

Low means that the pest has a minor impact on the standing crop and little effect on the stored products.

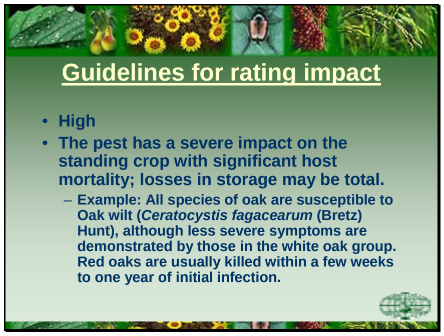
For example...Apple Rough Skin agent is responsible for loss of marketability of fresh fruit and is most significant on the apple varieties Golden Delicious, Belle de Boskoop, Schonen van Boskoop and Glorie van Holland.

Slide 24

Medium means that the pest has a moderate impact on the standing crop but host mortality is rare; losses in storage may occur.

For example...Apple maggot (*Rhagoletis pomonella* (Walsh)) is a fruit borer. Losses may be up to 75% of fruit if left untreated.

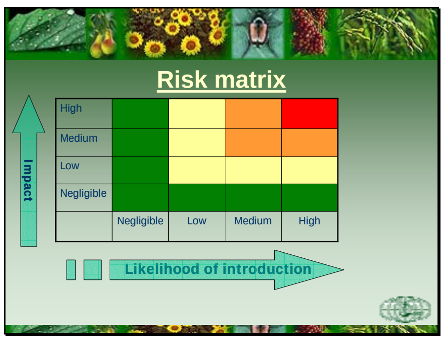
Slide 25



High means that the pest has a severe impact on the standing crop with significant host mortality; losses in storage may be total.

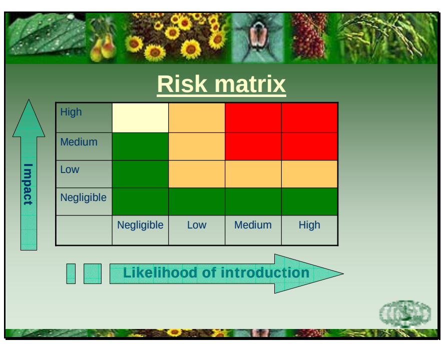
For example...All species of oak are susceptible to Oak wilt (*Ceratocystis fagacearum* (Bretz) Hunt), although less severe symptoms are demonstrated by those in the white oak group. Red oaks are usually killed within a few weeks to one year of initial infection.

Slide 26



If we go back to the risk matrix that we used earlier in the week and use a word scale for each of the aspects of the risk assessment of the likelihood of introduction and likelihood of impact then we can come to a conclusion here combining introduction with impacts and find where we are in this grid. These colours in the grid – the top right single red high risk, lots of green where everything is negligible (either with negligible likelihood or negligible impact). Pests that were deemed to occur in the red portion might require quite severe or multiple measures to bring the risk down to an acceptable level. Whereas pests that were in the orange or yellow portion might require less severe measures. This is one country example.

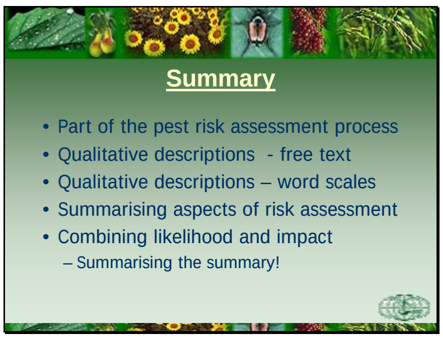
Slide 27



Another example is presented here with four red boxes in the top right and then orange and green. Note that even with a negligible likelihood but a high impact some sort of measure is necessary. Remember that a country has a sovereign right to determine what it judges to be acceptable risk. The assessment of risk is without measures in place so this is if nothing is done, what would be the likelihood and impact. Once it has been decided to do the risk assessment process and the risk management process has begun, then it is decided if it is acceptable or not. Then it is possible to come up with measures and then taking those measures into account repeat the risk assessment process and decide with the measures in place how would the assessment be changed. Change the position of the pest in the grid of the risk matrix. Would it alter it – is there sufficient measures in place to reduce the new perceived risk.

[Note to lecturer – this begins to overlap with risk management and could make reference to future lectures.]

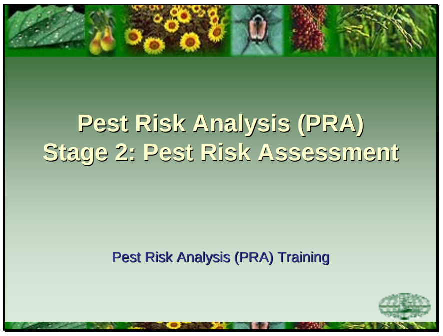
Slide 28



In summary, combining likelihood and impact to come up with an overall assessment of risk is part of the risk assessment process. Qualitative descriptions are free text and sentences. Word scales can also be useful and are used in risk assessment schemes around the world. Summarizing assessments of risk by combining likelihood and impact in a risk matrix to produce a summary of the summary is also very useful. The matrices, combinations of likelihood and impact and overall assessment all result in a summary of the summary!

Uncertainty

Slide 1



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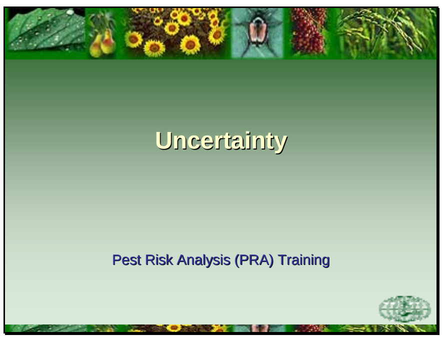

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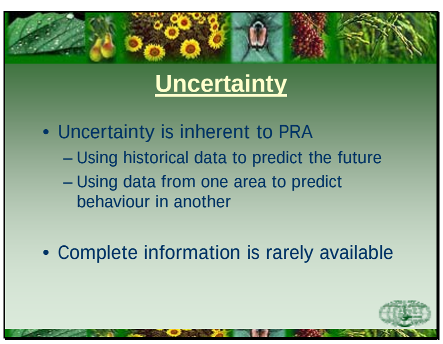
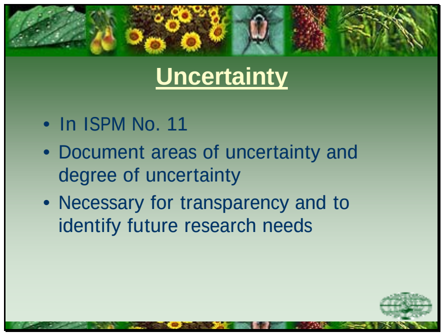


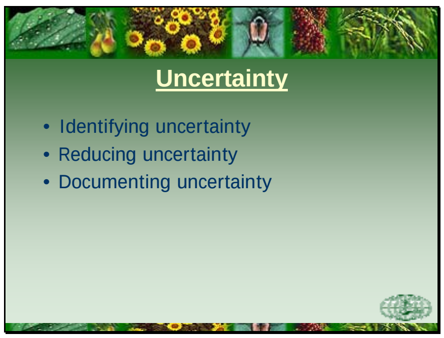
Uncertainty will always be a factor in Pest Risk Assessment – complete information is rarely available and in most cases analyses performed during PRA use historical data to predict the future. This can result in varying degrees of uncertainty. The important thing is dealing with the uncertainty in a way that is transparent and meaningful.

Slide 4



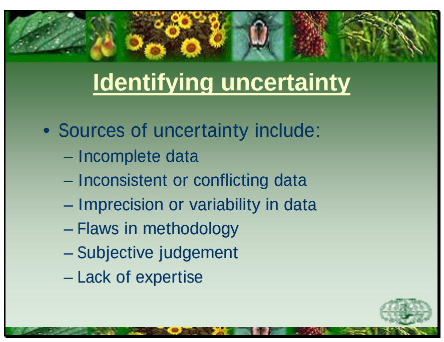
ISPM no 11 addresses uncertainty by stating that estimation of the probability of introduction of a pest and of its economic consequences involves many uncertainties. In particular, this estimation is an extrapolation from the situation where the pest occurs to the hypothetical situation in the PRA area.

Slide 5



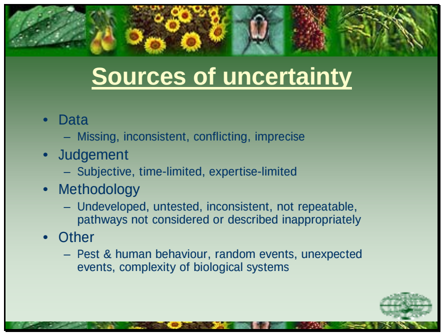
Uncertainty can be dealt with in these three steps. We will now take each one and talk about it in more detail.

Slide 6



The first step to addressing the uncertainty in a PRA is to identify its source. There are many possible sources of uncertainty. It may be attributed to things such as incomplete, inconsistent or conflicting data; flaws in methodology, lack of expertise, biological unknowns of the pest or pathways or many other things

Slide 7



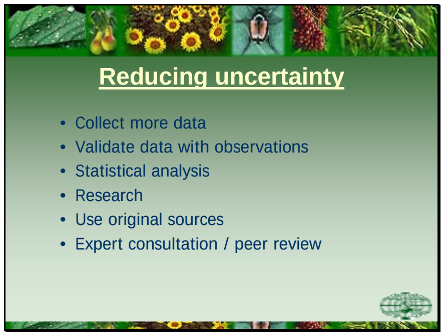
This slide illustrates some sources of uncertainty. Uncertainty in data could arise from missing data, inconsistent or conflicting data, imprecision or variability in data. There is a certain amount of judgement necessary when deciding which data is reliable and should be used in a risk assessment. Some data is not reliable and may be discounted or should be validated before it is included.

Judgement used when doing a risk assessment may also be a source of uncertainty as a result of factors such as lack of expertise, time constraints, and the subjective nature of risk assessment.

Pest risk assessment methodology may also be a source of uncertainty. This is a relatively new field of endeavour and models may either be unavailable, untested or inadequate, with the result that conclusions may be inconsistent. Since pest risk assessment is largely an exercise in predicting future events, it is also not often possible to test the chosen models or the conclusions. The identification and assessment of pathways is a critical factor in the reliability of the pest risk assessment, so errors here may also contribute to uncertainty.

Other sources of uncertainty can stem from random or unexpected events and the variable and complex nature of biological systems and pest or human behaviour.

Slide 8

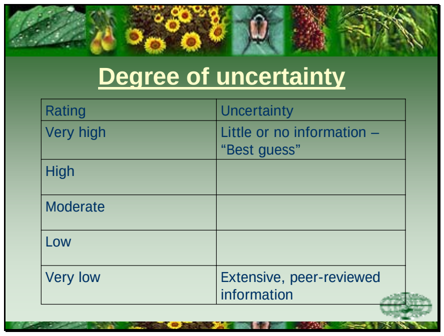


There are ways that pest risk assessors can deal with uncertainty in a pest risk assessment; some of these actions serve to reduce uncertainty. Actions such as collecting more data, validating existing data with observations, statistical analysis or new research, all contribute to reducing the level of uncertainty in a pest risk assessment.

The use of original sources of information as much as possible is also an important means by which to reduce uncertainty. Using secondary or tertiary sources for information can introduce errors in judgement, accuracy and bias which are each sources of uncertainty. The best way to be sure that you have the correct information and that it is applicable to your particular pest risk assessment is to look at the original paper in which the data was published.

Finally, do not forget the value of experts and peers. Expert judgement may be helpful in reducing uncertainty or compensating for it and building stakeholder confidence. It is a valuable way of ensuring that you have considered all of the pertinent information, that you have not misinterpreted data, and that you have not overlooked any important considerations. Where expert judgment is used, it is necessary to consult with a wide range of experts and consider all points of view. It is helpful to identify and document any assumptions that have been made and the impact these assumptions have made on the level of uncertainty and the conclusion of the pest risk assessment.

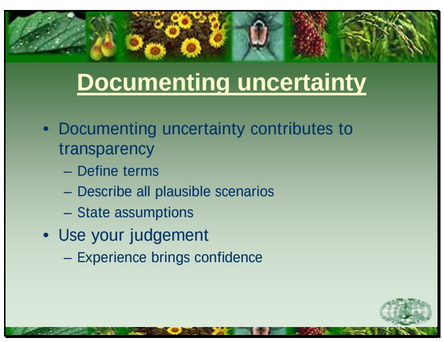
Slide 9



By "degree of uncertainty" we mean the magnitude of the uncertainty. This can be communicated using descriptive terms such as "high" or "moderate" as illustrated in this table. Here the uncertainty is very high if there was little or no information available to the risk assessor and he or she has had to make a "best guess". It is very low when there is extensive, peer-reviewed information available that is relevant to the issue; this enables the assessor to make an informed assessment.

For example you might have data from several quality peer-reviewed journals about the economic damage a pest does in country x. This could be reliable data, i.e., low uncertainty, with respect to damage done by that pest in that country. However, if it is the only information upon which to base an assessment of impact in the PRA area, which is not country x, the resulting pest risk assessment or prediction becomes less certain. This uncertainty results from the necessity of interpreting information generated by research in one context to another.

Slide 10



ISPM No. 11 (2004) emphasises the importance of documenting the areas of uncertainty and the degree of uncertainty in the pest risk assessment, and of indicating where expert judgement has been used. This will contribute to transparency and can be valuable information when decisions are being made on the acceptability (or not) of the pest risk. Documenting the uncertainty may also be useful for identifying and prioritising research needs or areas where phytosanitary measures might be applied to reduce uncertainty.

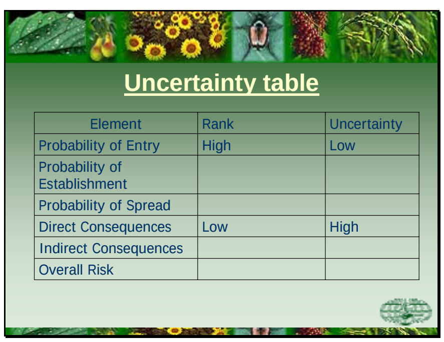
When documenting uncertainty, as in all aspects of pest risk assessment, it is important to be clear about what you mean; define the terms that you are using and use them consistently. The IPPC glossary of terms may be very helpful in providing a source for accepted, consistent definitions.

Also, be thorough. Describe all the plausible scenarios that you have considered in your pest risk assessment. For each, state what is known for certain and what assumptions you are making.

Assumptions can be made, for example, when only one criterion is being examined and we are missing information. But what if we are wrong and we should be examining more criteria - e.g. we assume there is only one pathway for pest X from country Y and the phytosanitary measure Z will reduce the risk to an acceptable level. We think that we can control the pest using Z. But what if there are other pathways we don't know about or didn’t’ consider? The assumption that there is only 1 pathway was a big assumption. It should be pointed out that other pathways may exist. By this, I'm not saying I'm uncertain about the known pathway, but that there may be others and this is where the uncertainty occurs.

Identification of the assumptions and uncertainties will ensure a comprehensive and objective view of the pest risk.

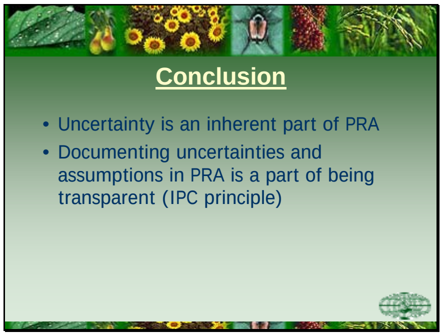
Slide 11



One way of presenting information at the end of a risk assessment, would be to plot the sections in a table across from the risk ranking (e.g. probability of entry is high) and the uncertainty ranking (e.g. uncertainty is low).   In this example, the risk assessor estimates that the probability of entry of the pest is high, and he or she feels fairly confident that this is correct, so uncertainty is low.

In assessing the potential direct consequences of the pest, however, the assessor has estimated it to be low, based on the available information, but indicates that his or her uncertainty is high. Subsequent decisions or actions taken should take this into account.

Slide 12



Although it may seem difficult to spend a lot of time doing a PRA than to admit the uncertainties - PRAs can be criticised because of the uncertainties, and it is a difficult job. As good scientists it is our job to say what assumptions have been made, and where there are uncertainties, and to admit when we can't be sure – it's about being honest and transparent in keeping with IPPC principles. PRAs are still very useful and are needed, highlighting uncertainties might make the assessments seem less valuable, but this is not so - as long as we do our best within the resources we have available, then that is all that can be expected. It is hard, but the more we do PRAs, the better we get at it.

Communicating with others - e-mail each other, talk to each other, share information - this is how we can reduce uncertainties.

Risk Management

Slide 1

Slide 2

Note to Presenter:

This talk covers the third stage of PRA, the pest risk management stage -- from the conclusions of the pest risk assessment to the identification of appropriate risk management measures (if any). It's a relatively long talk and a whole new subject so its important to make sure everyone is understanding things right from the start; the material will be reinforced in the exercise, but there are no additional lectures, as there were for pest risk assessment. Perhaps the most difficult part is the transition from Stage 2 to Stage 3. The ISPMs do not provide any guidance for determining if a risk is acceptable or not, yet this is a critical step between Stage 2 & Stage 3.

This slide just reminds participants of what has been covered and where the material in this talk fits in the PRA process.

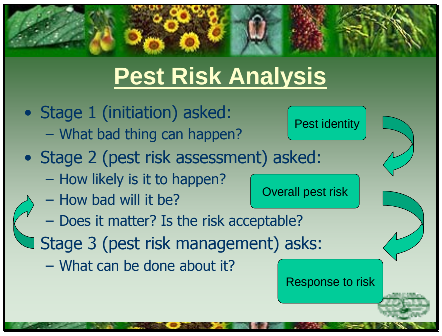
Points:

We have spent the last couple of days focussing on pest risk assessment – on our first day together we learned about the initiation points that may be reasons to conduct a PRA, and we initiated a pest risk assessment ourselves. From there, we learned about Stage 2 of the PRA, pest risk assessment and we have conducted a pest risk assessment together, considering both the probability of its introduction in our scenario, and its likelihood of entry, establishment and spread, and the magnitude of the potential environmental, economic or social consequences that could result if the pest were to become established in our PRA area.

We have reached a conclusion about the overall pest risk of our pest example and today we must consider if the PRA should continue or not.

Today, we will learn about Stage 3 of the PRA process, pest risk management.

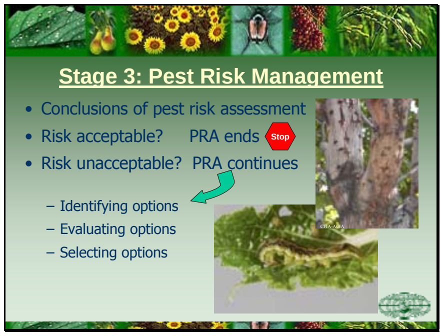
Slide 3



As we start Stage 3 of the PRA process, we consider the conclusions of the pest risk assessment completed in Stage 2. The pest risk assessment considered two basic questions about pest risk – how likely and how serious. As the pest risk assessment concludes, we have reached a conclusion about the overall pest risk. If that pest risk is assessed and considered to be acceptable, the PRA may stop. If, however, it is not acceptable, then the PRA continues to Stage 3 where we consider whether or not there is anything that can be done that will lower the overall pest risk to an acceptable level.
PRA is a very iterative process – that means each time you learn a little bit more about the pest, or you add new information that might change the conclusions of the PRA, you may need to reconsider the questions you've already thought about in an early run through the process.

This is especially true as we enter Stage 3 and start to consider the effects of mitigation measures on the likelihood or impact of the pest. The overall pest risk is originally assessed without any mitigation measures. If one or more risk mitigation measures are proposed to reduce the pest risk, then a re-assessment of pest risk can be used to determine the effects of the proposed measures.

Slide 4



The pest risk management stage begins with the conclusions of the pest risk assessment. Remember that the pest risk assessment concluded by identifying an overall level of risk for the pest on a particular pathway or in particular circumstances. A decision has to be made now on whether the risk from each assessed pest/pathway combination is an acceptable risk or not.

This decision will be based on the relationship between the level of risk identified in the pest risk assessment stage (i.e. the combination of the probability of introduction and the potential economic impact) and the importance/desirability of the trade that carries the risk of introduction of the pest.

The level of risk may be acceptable, in which case the PRA may end.

If, however, it is <u>not</u> acceptable, then the PRA continues by:
identifying the possible mitigation measures that can be applied to mitigate the risk,
evaluating each of those options, and selecting appropriate measures which will reduce the risk to an acceptable level.

Slide 5

The overall level of risk as identified in the pest risk assessment can be expressed in a number of ways. The IPPC standards do not specify how overall risk should be described.

In general, risk can be described in comparison to existing pest risks or existing phytosanitary requirements -- for example, a PRA for one species of fruit fly on stone fruits might conclude that the pest presented a higher or lower pest risk than a second better known fruit fly of quarantine concern for which measures are currently in place.

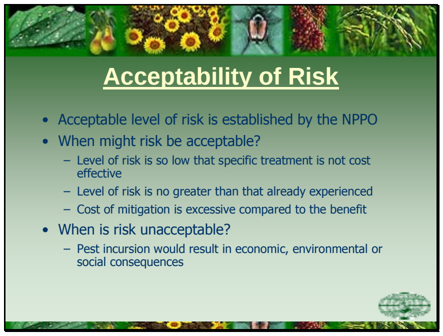
Or risk can be indexed to estimated economic losses --- for example, the risk of bacterial blight in bean seeds for planting from country X is moderate since approximately 1 seed lot in 5500 is likely to be infected 9 times out of 10 with the result that an outbreak is expected once every 50 years with losses totalling X million pounds (dollars, yen, rupees, kroner... use local currency) expected during outbreaks.

Some models express risk on a scale, for example of 1 to 10, of risk tolerance, where 1 is negligible or no risk and 10 is a very high or extreme risk – this is a system that requires the NPPO to develop a national model in which the scale is pre-defined and can be explained to others and used consistently by pest risk analysts

Risk could be expressed in comparison to the same pest at a different time of year or in different circumstances, for instance a particular pest may be a much higher risk at some times or year than others in some climates. A pest risk assessment might conclude that the pest risk associated with logs imported to a northern European or Canadian port for pulp-making, for instance, is much lower in February than it is in June when opportunities for establishment are much greater.

Or in other countries, or other commodities –- for example, the risk of sorghum rust is equal to that of sorghum root rot which is already present in the PRA area and more significant than that of sorghum leaf blight which is a listed quarantine pest in the PRA area.

Slide 6



Note to Presenter: a key point to get across here is that some pest risks are acceptable and that each NPPO gets to decide what is acceptable and what is not; if the risk is acceptable, the PRA stops and no mitigation measures are applied. Sometimes, participants will be so focussed on pest risk that they forget that sometimes, the pest risk will be such that no measures are necessary and it is preferable to accept the risk than to try to mitigate it. The trick is to keep an open mind until the end of the pest risk assessment and then to consider its acceptability with the possibility that it might be acceptable in mind.

Points

Just as the PRA standards do not say how overall risk should be expressed, they also do not specify what level of risk is acceptable or not acceptable – the determination that an identified level of pest risk is acceptable or not is the right of each NPPO. It the responsibility and the sovereign right of each NPPO to determine what level of risk is acceptable.

So when might a risk be acceptable?

It could be so low that the costs of lowering them further, for example, are greater than the impacts of the pest itself. If the pest has negligible impacts, for example it is a minor fruit tree virus which has no measurable impact on the tree's longevity or productivity, then implementing mitigation measures to prevent its entry are likely to be more costly the impacts that will occur if the pest establishes in the PRA area.

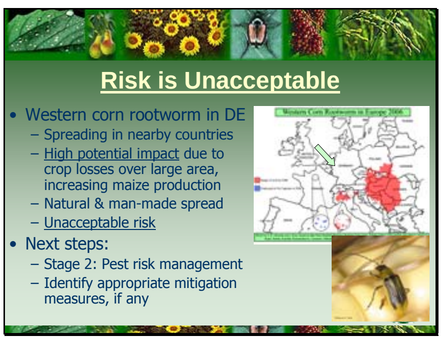
Or, if the pest risk is no greater than that which is already experienced within the PRA area or can be managed through practices that are in place already, then there is no reason to impose mitigation measures as they will provide no added protection.

And finally, even if the pest is a serious one that poses great risk, there may be benefits to allowing the import and the costs of mitigating the risk may be

greater than those benefits.
The decision that the pest risk is acceptable can be a complex one, requiring the balancing of costs and benefits in the context of the economic and other circumstances within the PRA area.

Deciding that the pest risk is unacceptable is perhaps more straight-forward, and one which PRA specialists are perhaps more accustomed to. The pest risk may be considered to be unacceptable if the pest incursion is expected to result in economic, environmental or social consequences. Whether these costs are acceptable or not, of course, depends on the situation in the PRA area, including economic circumstances and priorities and the significance of the resource at risk in the PRA area.

Slide 7



Let us look at the specific example of Western Corn Rootworm, a situation in which a PRA has been completed and the pest risk has been determined to be unacceptable.

The pest in this case is western corn rootworm, or *Diabotrica virgifera virgifera*. The western corn rootworm (WCR) is one of number of rootworm pests that collectively are the most destructive insect pest of continuous corn in the United States. Treatment expenses and crop losses due to corn rootworms cost U.S. producers about $1 billion per year.

First found in Europe in 1992 in Yugoslavia, it has since been found in an increasing number of locations; spread has occurred by means of adult beetle flight and by airplane and vehicular transport. The map illustrates in red the areas where the beetle was active in 2006, and in blue, those areas where the beetle was eradicated or not found that same year. The beetle is now close to the southern border of Germany, one of the major maize growing countries of Europe.

Western corn rootworm overwinters in the egg stage. Eggs start to hatch in late spring, depending on soil temperature.

After hatching, the small rootworm larvae move to nearby corn roots and begin feeding on root hairs and small roots. Larger rootworms feed on and tunnel in primary roots. Under heavy rootworm pressure, root systems can be completely destroyed. Economic losses occur after one or more primary roots have been significantly destroyed by the larvae.

A study was undertaken to assess the potential pest risk of Diabotrica virgifera to a number of European countries. It concluded that WCR would probably continue to spread in Europe, for example into France, Switzerland, Germany and Austria where over 10 years around 1,354 million ha of maize could be infested and millions of Euro's worth of damage be caused.

A decision was taken that this represented an unacceptable risk and the risk mitigation measures should be considered.

Slide 8

So what exactly is "pest risk management"? How will it help us decide what to do next and what is appropriate?

Pest risk management is a systematic way of analysing potential mitigation measures to determine which would be most appropriate means by which to minimize the identified risks.

Mitigation measures may be applied at many **points in the life** of a plant or plant product, from the seed stage, to the growing plant, the harvested commodity, or the final product ready for shipping, including any of the materials associated with it, such as packing materials, growing media, containers etc.

Measures may also applied at any **point in the travels** of the commodity, from the country of origin where it was first produced, during the time that it is undergoing any processes in preparation for its shipment elsewhere, during shipment, or at any point along its travels in the receiving country.

The pest risk management stage considers the full range of mitigations measures that are available and the many points at which they might be applied, to determine the most appropriate treatment or combination of treatments to reduce the level of risk of the pest to an acceptable level.

Slide 9

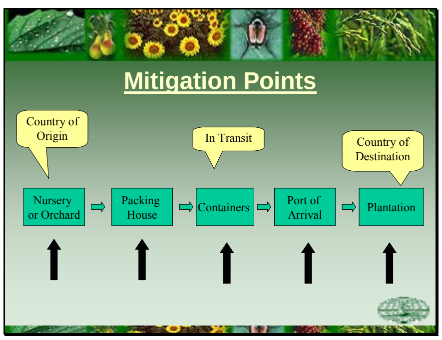
A structured, organized approach to pest risk management will help to ensure a thorough review of all possible mitigation measures. A good place to start is by identifying all the possible pathways by which the pest might enter include all traded commodities, like plants or plant products, which might be moving in international trade and might be carrying the pest
Include also any natural spread of the pest, by natural migration, for instance, or by wind, water and other forms on transportation
Pests may also spread on vehicles, in trains, planes or automobiles, for example, but also in ships or infesting materials associated with these forms of transportation or with intentionally transported goods

Next, develop a picture of route by which the pest might move – identify all the points between the point of origin and the final destination, at which there might be opportunities to apply mitigation measures and interfere with the movement of the pest
Pests, like people, do not move instantaneously between points – they follow a route which takes them from place to place to place, before they finally end up introduced in a new locale
In developing the pest risk management phase of the PRA, it is helpful to consider the likely routes of entry that the pest might take

The next step is to identify all the possibly mitigation measures that might be applied at any particular spot along this route – we just learned that measures can be applied at any point in the country of origin, during transport, or even in the country of destination; the challenge in pest risk management, is to determine which measures to apply at what point along the route in order to reduce the level of risk to an acceptable level.
So, assess each possible mitigation option to determine which is most effective, most feasible, most efficient
And select those measures or groups of measures that will bring your risk level down to an acceptable level
There may be one or more measures that will work; you may want to offer a choice of options

This is the process of pest risk management. Taken one step at a time, like pest risk assessment, it's a systematic, informed approach to determining what risk management requirements may be appropriate for the pest in question.

Slide 10



Here you see a little scenario diagram illustrating the route by which a pest of fresh fruit, for example, might move from one area to another.

This is an example of a scenario diagram developed to illustrate the movement of a hypothetical plant pest affecting an orchard crop. The green boxes illustrate the points along the pathway by which the pest moves; the black arrows indicate the points at which mitigation measures might reasonably be applied to good effect.

In the country of origin, the pest flourishes in the nursery or orchard where fruit is being grown for sale. When the fruits are ripe and are harvested, they are boxed up and taken to a packing house where they'll be prepared for export. The pest comes along in or on the harvested fruits. From the packing house, boxes are loaded into containers and are trucked to the airport where they are loaded onto planes and are sent off to the country of destination. Again, the pest is carried along with the fruit. At the port of arrival, the containers are opened and the boxes are unloaded and taken to distribution centres across the country. The pest still comes along. Eventually, the boxes are opened, the fruits are distributed and the pest flies out where it finds a suitable host in a nearby plantation, at which point it is said to have entered the PRA area.

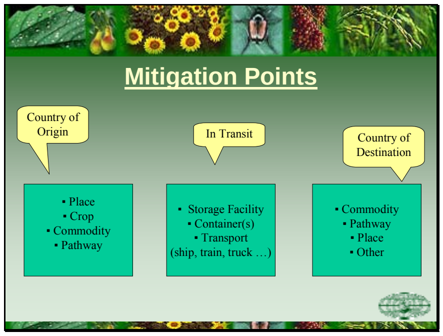
If, however, mitigation measures are applied at one or more of the points along this journey, the pest might be prevented from finding its way to these vulnerable hosts, enter and get established. For instance, measures applied at the orchard could reduce the population level to such an extent that there are no pests present in the harvested crop, or measures applied in the packing house could reduce pest numbers.
Fumigation in the containers might kill all of the pests in the fruit before the pest arrives with the fruit in the destination country.

In the risk management process, the analyst examines all of these possibilities and select those measures and application points that provide the most appropriate protection.

This is just a very simple scenario diagram of a hypothetical situation. In real life, scenarios may be straight-forward like this one, or highly complicated. There may be one or many potential intervention points where mitigation measures may be possible. Or there might be none.

Developing the scenario for a pest risk assessment requires information about the pest's biology, the host's biology, the production practices in the country of origin and the industry and trade practices for any commodities which may be pathways. Sources of this information may include published literature, internet sites, information provided by the exporting country NPPO, industry representatives and the importer.

Slide 11



Mitigation points may be applied at one or more points along the continuum from the site where the plant or plant product first grows in the country of origin to its final disposition in the country of destination.

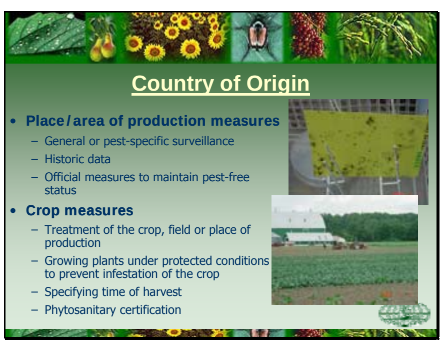
In the country of origin, measures may be applied to the place where the plants are grown, on the growing crop, on the commodity after harvest, or on associated products that are part of the pathway.

Likewise, measures applied during transit may be appropriate – including measures applied during storage, while the commodity is in containers or during transportation by sea, rail or road.

Finally, measures applied at the country of destination may be appropriate – depending on the pest in question, measures applied at destination to the commodity, the pathway, or the place of arrival may be the selected option.

Determining which mitigation measures to apply when and under what conditions is what pest risk management is all about. ISPM 11 lists some examples of measures that may be applicable and which can be considered during Stage 2 of the PRA.

Slide 12

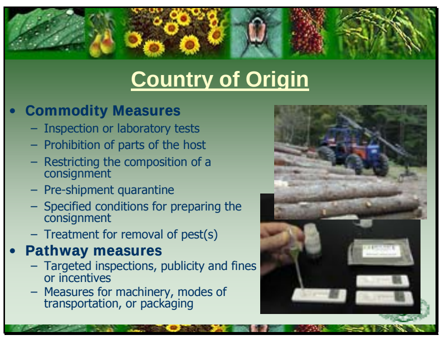


Place or area of origin measures that might be appropriate include:
Pest surveillance information – the exporting country NPPO may have survey information about the pest's presence or absence in the production areas which can be used to support the application of mitigation measures, or declarations of freedom from the pest
Historical pest information may be available which is still valid and which can be used in the same way
The exporting country NPPO may have official control measures in place to support declarations of pest freedom in the area or place of production

Likewise, crop measures may be applied to the specific crop from which plants or plant products are to be

exported. These measures may include:
Pesticide applications on the growing crop and other pest control practices, including integrated pest management, sanitation etc.
Growing plants in protected conditions, such as in glasshouses for example, to prevent infestation is another valid option [*the top picture shows a sticky trap placed in a glass house as a means of monitoring the site for the presence of flying insects, in order to provide evidence for the certification of pest freedom on crops grown therein]*
It may be appropriate to specify the time of year at which harvesting or shipping is required to take place, in order to prevent pest entry
And crop certification, is a valid option – an importing NPPO may require that the exporting NPPO certify the site, the crop or the commodity to be free of the pest of concern

Slide 13



Likewise, measures may be **applied to the commodity** after it has been harvested and during preparation for export while it is still in the country of origin. Possible measures include:
laboratory testing, for the presence of viruses in planting stock or seed, for example
Prohibiting parts of the plant likely to be infested with the pest is another possible measure – for example, the requirement that nursery stock for planting be dormant, that it have no leaves, may prevent the entry of certain rust diseases which are present only on the open leaves of infected plants and removal of bark from wood products provides protection from bark beetles which may otherwise survive considerable time under bark attached to harvested wood products
Restricting the composition of the consignment may also be a means to prevent entry of pests – for example, importing varieties of plants that are resistant, or less susceptible, to the pest of concern
Pre-shipment quarantine, the requirement that a shipment be isolated and observed for a specified period of time prior to shipment in

order to confirm or maintain its pest-free status, may be an effective means of mitigating pest risk in certain circumstances; non-dormant nursery stock, for instance, may be protected from infection by rust spores if they are isolated in a quarantine facility during the critical leaf-out stage

Specifying the packaging materials that are to be used, the inspection procedures or other preparations that the commodity must undergo or the storage conditions under which the commodity must be maintained prior to shipment are additional potential measures which may be effective

And, of course, there is the option for removal of the pest from the commodity prior to shipment, by means of a specified treatment or series of treatments; examples include washing of fruits, surface sterilization by hot water or chemical treatment or fumigation

Measures that may be **applied to the pathway**, may also be appropriate. Targeted inspections and other measures applied directly to the pathway, measures like publicity, fines, and incentives, may be effective. For instance, many NPPOs use literature, radio announcements and film clips as a means of mitigating the risks associated with passenger baggage carried by travellers returning from other countries. Measures may also be applied to pathways that are not plants or plant products, when they present an unacceptable pest risk. Measures including surface washing, inspection, or fumigation, for instance, are sometimes applied to machinery, vehicles or packaging materials that are infested with soil, for instance. ISPM 15 describes measures recommended for wood packaging materials to mitigate the risk of live pest infestations.

[*this could be an opportunity to solicit other examples of measures applied to commodities or pathways from participants*]

Slide 14

Mitigation measures may also be **applied in transit** – during transportation between the country of origin and the country of destination, including in any countries through which the commodity is transported en route to its final destination.

These measures may include things like specifying storage conditions for the commodity:
Storage temperatures, for example, may be lethal for certain pests
Packaging materials may be pathways for certain pests, so specifying the nature of packaging materials can contribute to mitigating pest risk
Likewise, for pests which have multiple hosts or whose life cycle depends on its alternating between hosts, separation of commodities may be an effective mitigation measure

Treatment of commodities during transit is sometimes a feasible option; depending on the pest, commodity, health concerns and the physical attributes of the ship, ship board fumigation or other treatments may be appropriate.

Ship or rail car inspection may also be an important mitigation measure for certain pests whose behaviour and life history make transportation on vehicles a possibility. Rail cars, for instance, that have been used to transport grains from an infested area may be contaminated with fungal spores, weed seeds or other pests and should be cleaned and inspected prior to being used to ship plant products to prevent pest contamination. Likewise, gypsy moths, attracted by the lights at ports, may lay eggs on the surfaces of containers or ships; inspection prior to loading may be an effective means of mitigating this risk.

Slide 15

Mitigation measures may also be applied in the country of destination – either directly on the commodity or pathway, or by other means. Many of the commodity & pathway measures that may be applied in the country of origin may also be effective in the country of destination. These include inspection of consignments, treatment of consignments or associated products, containment and restricted end-use or post-entry quarantine. Restrictions on the use, timing or distribution of consignments are also an acceptable means of mitigating pest risk.

Finally, other measures such as public education, advertising, public notices and specific education of key target audiences, like importers, travellers or special interest groups, may be an effective means of mitigating pest risk. The use of amnesty bins in airports, for example, where travellers may safely dispose of plants and plant products carried in passenger baggage provides an excellent way of preventing pest entry.

Education of travellers, importers, special interest groups, researchers and industry stakeholders is an additional measure for mitigating pest risk.

Slide 16

A very strong measure to reduce pest risk is the prohibition of specified commodities from specified origins. Note that prohibitions should apply only to specific commodities from specific sources, based on the conclusions of the pest risk assessment and following a review of other potential mitigation measures.

This should be a last resort option, one that is selected when no other effective mitigation measures are available and the pest risk is unacceptable, in keeping with the IPPC principles as discussed earlier – those being necessity, science-base, managed risk and minimal impact.

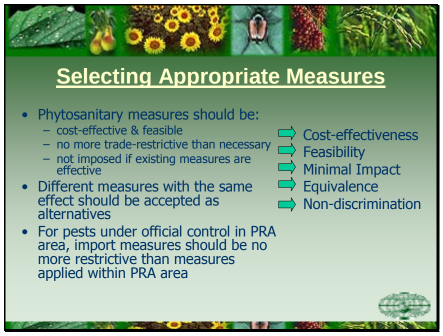
Slide 17

In addition to mitigation measures which may be applied to a consignment or pathway, additional safety precautions may be considered. Amongst these is documentation. We are all familiar with Phytosanitary Certificates; these are official forms which are issued by the NPPO of the exporting country and provide official assurance that the requirements of the importing country for the identified consignment have been met. By signing a Phytosanitary Certificate, the exporting NPPO confirms that the required risk management measures have been taken and that the consignment meets the importers requirements. Phytosanitary Certificates should only be required for regulated articles. ISPM No. 12 provides further guidance on phytosanitary certificates.

Certificates are not, however, the only form of documentation that an NPPO may use to mitigate pest risk. Import permits and other official designations may also be utilized, at the NPPOs discretion. The official IPPC stamp indicating that solid wood packing materials meet the minimum requirements of ISPM 15, for example, is an official form of documentation and is recognized world-wide and the standard is increasingly adopted.

Education, too, is a powerful tool and a means by which to mitigate pest risk. Information provided to importers, travellers, industry stakeholders, researchers and others may contribute to a reduction in pest risk along certain pathways by alerting people to the import requirements of the country they are entering and the hazards of transporting plants and plant products without meeting these requirements.

Slide 18



ISPM provides guidance regarding the selection of appropriate measures. Not all possible measures will be appropriate – some may not work, for instance, or their application will be prohibitively expensive or not feasible. Selection of appropriate measures should be undertaken with the IPPC principles in mind [green arrows indicate principles].

You will remember that ISPS No. 1 outlines the principles of the IPPC. Amongst these are several that are particularly important when selecting appropriate mitigation measures:
cost-effectiveness
Feasibility
Minimal impact
Equivalence and
Non-discrimination
are all important principles to keep in mind when choosing which mitigation measures to apply in a given circumstance.

Appropriate measures will be both cost-effective and feasible; they will not be any more burdensome to trade than necessary to lower the level of risk to an acceptable level, and they will not be imposed if existing measures are already effective. Furthermore, ISPM 11 explains that different measures having the same net effect should be considered to be equivalent and equally acceptable provided they both lower the level of risk to an acceptable level.

For pests that are under official control in the PRA area, measures applied to imports should be no more restrictive than those that apply to goods moving within the PRA area.

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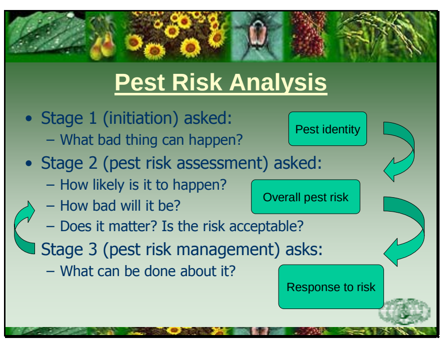
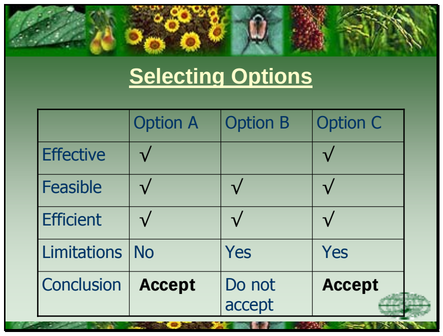
For each option, then, that has been identified as a possible mitigation measure, the analyst must determine:
Is it effective in reducing pest risk to an acceptable level?
Is it efficient, keeping in mind the IPPC principle of minimum impact, does the treatment reduce pest risk without minimal waste and cost?
Is it cost effective? To put it very simply, is the cost of the measure less than the cost of not mitigating? It may be necessary to conduct a cost-benefit analysis of the proposed measures in order to determine its cost-effectiveness.
Is it feasible? Practical? Is it actually physically and practically possible to implement the requirement?
It is reproducible? If the same measure is applied to the same or similar consignments, does it yield the same results each time?
And will application of the treatment result in potential negative social, economic or environmental consequences? If the results of the treatment are worse than the pest would have been, then the measure is probably not a suitable one.

Slide 20



Keep in mind the iterative nature of pest risk analysis. With each mitigation measure that is applied, there is an effect on pest risk. During the evaluation of mitigation measures, it may be necessary to reconsider the pest risk assessment to determine the effect of that measure on overall pest risk. PRA is a very circular process – evaluate the risk – mitigate the risk – evaluate the effectiveness of the proposed measure and re-evaluate the risk.

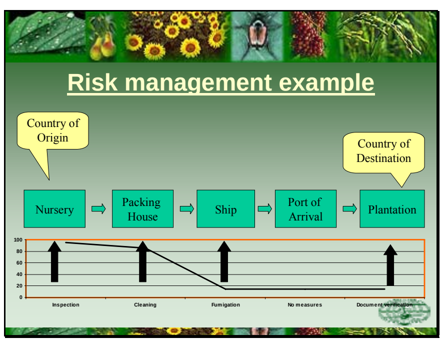
Slide 21



Selecting the acceptable mitigation measures then requires consideration of the results of the evaluation of each of the possible measures. ISPM 11 does not provide detailed guidance to NPPOs for how to select options or display the information processed during the pest risk management stage of the PRA. A simple table such as this one may be a model to follow, or you may find another system is preferable. In this table, the options may be a single measure, such as a specified chemical treatment, or a series of treatments, such as fruit bagging, following by inspection and a surface treatment. Each option is evaluated against the same set of criteria, and those that are acceptable are selected.

The critical things to remember are to:
Consider all possible options, either singly or in combination
Evaluate the possibilities equally
Select the options that will achieve the desired level of protection

Slide 22



Let us consider a final example. Here we have the example of a hypothetical seed- and insect-transported fungal disease of pine trees, which causes die-back of individual branches, leading to a general decline and premature death of infected trees. Pathways include seed and nursery stock.

In this scenario diagram, the fungus is present in a hypothetical nursery in the country of origin. Seed from this nursery is harvested and sent to a packing house where it is cleaned, graded and packaged up for shipping. It is sent by air mail to the port of arrival and from there to a plantation in the country of destination where it is intended to be planted. Since the fungus is seed-borne, it is transported along this pathway and potentially becomes established in the country of destination.

The black arrows, remember, indicate points along the pathway at which mitigation measures may be applied.

The graph overlaid on the arrows indicate the level of pest risk on the vertical axis. At the starting point, pest risk is quite high.

In this example, we could apply a nursery inspection in the country of origin to ensure that trees from which seed is harvested are disease free and apparently healthy; the result is that pest risk drops somewhat. It does not drop a great deal because inspection for healthy trees is not a highly effective measure and it would be easy to miss an infected tree and harvest seed contaminated with the fungus.

In the packing house, we could add a cleaning step and remove plant debris from the seed so that we were only accepting clean seed. This too has the effect of lowering the pest risk but again, some infected seed may go undetected as the fungus is an internal contaminant of the seed.

And finally, on the ship, the seed could be subjected to a fumigation treatment which is highly effective and eliminates 99.9% of the infection. Pest risk drops suddenly to below the minimum acceptable level and the seed may continue with no further restrictions.

At the port of destination, a final check of documentation to verify that these measures have been undertaken is all that is in order.

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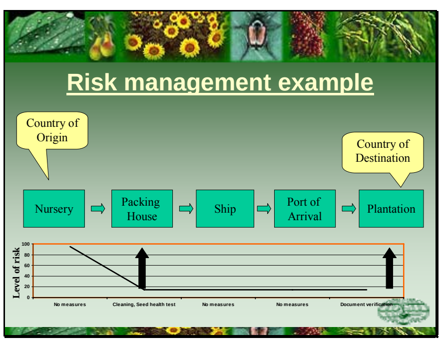
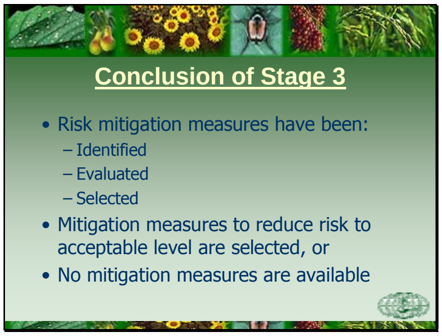


Here we have the same scenario, with a different set of mitigation measures. Instead of inspecting the nursery, cleaning the seed and fumigating the final consignment, we clean the seed and subject it to a seed health test in the country of origin. The seed health test is highly reliable and provides a high level of assurance that seed is free of the pathogen. Only batches of seed that pass the check are allowed for export. The level of risk drops very significantly then, to below the level of acceptable risk, and no further measures are necessary, except for the final documentation verification in the country of origin.

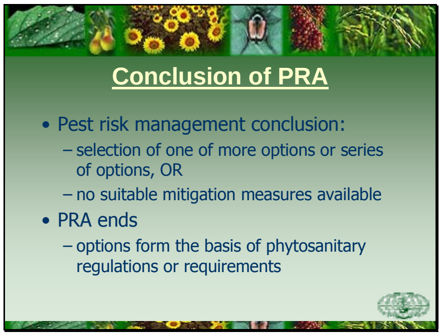
In this example, then, we have seen two different approaches to mitigating the same pest risk. In both cases, the level of risk was reduced to an acceptable level and the seed moved successfully from the country of origin to the country of destination. These two scenarios describe equivalent measures, since they achieve the same level of protection. In both cases, no further measures are required after the level of risk has been reduced to an acceptable level.

Slide 24



At the end of Stage 3, risk mitigation measures will have been identified and evaluated, and ultimately those that meet the evaluation criteria and lower the pest risk to an acceptable level are selected. If no measures are available, this is noted.

Slide 25



The conclusion of Stage 3, pest risk management, also marks the conclusion of the PRA. At the end of the pest risk management stage, the analyst has selected one or more options or series of options to reduce the pest risk to an acceptable level, or has identified that no suitable risk mitigation measures are available. The PRA concludes with the identification of these preferred options, which ultimately form the basis of phytosanitary regulations or requirements.

An important component in the selection of options is cost-benefit analysis, which we have mentioned only briefly up until now.

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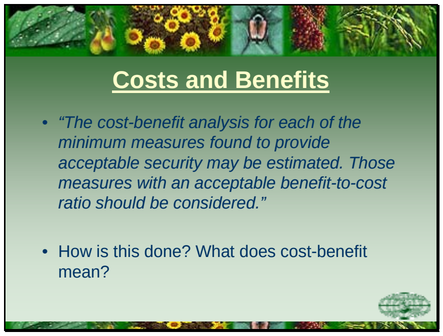
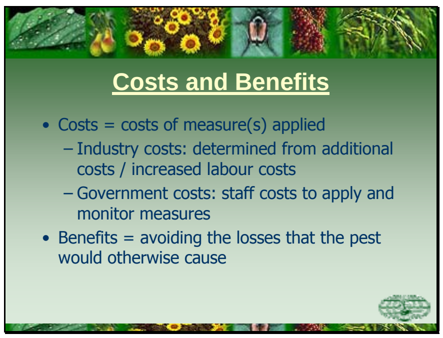


We will now explore cost benefit analysis in more detail.

Although the SPS Agreement does not mention benefits in any context within its text, ISPM 11 (on PRA) does mention benefits in section 3.4 which states" The *cost-benefit analysis for each of the minimum measures found to provide acceptable security may be estimated. Those measures with an acceptable benefit-to-cost ratio should be considered.*"

So how do we do this and what does cost benefit really mean in the IPPC context?

Slide 27

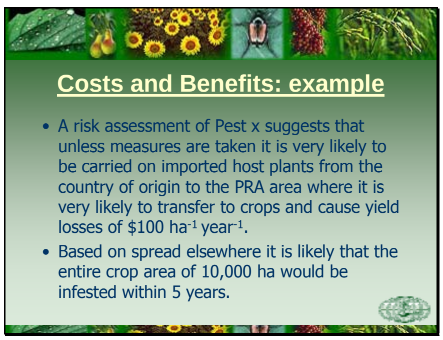


Costs are the costs associated with any measures that are applied against a pest, whether those are industry costs or government costs. Costs that might be incurred by an affected industry party may include such things as increased labour costs or additional production costs for treatments, inspections, delays in shipping etc. Government costs, on the other hand, include labour and supply costs for inspections, surveys, verification of treatments, issuance of phytosanitary certificates or other official documents etc.

On the positive side, benefits are those losses that are avoided but would otherwise have been incurred, either to government, the affected industry stakeholders, or third parties. For example, if measures are taken to prevent the introduction and establishment of a plant quarantine pest that, if introduced, would cause crop losses and loss of export markets, then the benefits of the proposed mitigation measures would be no crop losses and maintenance of the export markets.

Keep in mind when selecting appropriate measures that any treatment(s) should be proportionate to the pest risk it addresses. When considering whether to implement measures, the cost of the measures to the industry that will be affected and the government costs for implementing and enforcing/ monitoring the measures should be considered. If those costs are greater than the losses that the quarantine pest is likely to cause if no measures are taken, then it is questionable whether the measures are suitable or justifiable.

Slide 28



Let us look at a simplified example. A pest risk assessment has been completed on Pest X which concludes that unless measures are taken, it is very likely that Pest X will be carried on imported host plants from its country of origin to the PRA area where it is likely to transfer to susceptible crops and cause yield losses of one hundred dollars [substitute ruppees, yen, kroeners etc.]. Based on spread elsewhere, Pest X is likely to spread throughout the entire crop area of 10,000 hectares within 5 years.

The PRA concludes that the pest risk is unacceptable and risk mitigation measures have been evaluated. To select which measure is most appropriate a cost-benefit analysis is conducted.
To be economically worthwhile, the cost of measures should be less than the cost of potential losses.

Slide 29

Four risk mitigation measures are possible options.

The first option is to source imported plants from a pest-free area. This would be a relatively low-cost option for both the industry and the government, but the exporting country is unable to establish a pest-free area. Implementing this measure would mean that the importing industry would be unable to acquire the desired plants – a very high cost.

A second options would be to prohibit certain plant parts, for example leaves, and import plants at a time of year and in a life stage, perhaps dormant plants or seedlings, that would not be a pathway for the pest. The costs of implementing this measure would stem from the additional costs this would place on the importing country for changes in its production practices and on government for the inspection and certification measures that it would be required to implement in support of this requirement. In our example, these costs add up to 10,000 dollars (pounds, yen, rupees…) per year.

A third mitigation measure that has been identified could be the inspection of the crop at origin and the application of chemical treatments where needed, followed by the inspection of import consignments prior to export. Costs associated with this option would be incurred by the exporting country to some extent, but these may be passed onto the importer in the form of increased costs for the imported plants, and costs to government for the inspection, review of documents, off-site visits to verify the exporting country's phytosanitary procedures etc. These costs total more than the previous option, perhaps as much as 40,000 pounds per year.

A final option that would mitigate against the pest and still allow importation to occur would be post-entry quarantine – the establishment of facilities and conditions under which imported plants would be required to be held for a specified period of time after importation before they could be released to the importer for the intended end-use. The costs of this measure can reasonably be expected to be very high, since both the importer and the government would incur high costs for facilities and staff to house the plants, maintain them in good condition for the required period of time, inspect them as needed, issue the necessary documents etc. Our estimate of the cost of this measure is 300,000 dollars a year.

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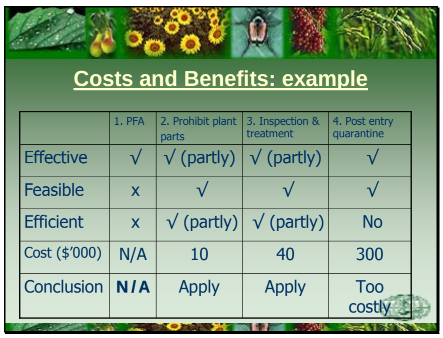


	1. PFA	2. Prohibit plant parts	3. Inspection & treatment	4. Post entry quarantine
Effective	√	√ (partly)	√ (partly)	√
Feasible	x	√	√	√
Efficient	x	√ (partly)	√ (partly)	No
Cost ($'000)	N/A	10	40	300
Conclusion	**N/A**	Apply	Apply	Too costly

Selecting the acceptable mitigation measures then requires consideration of the results of the evaluation of each of the possible measures. ISPM 11 does not provide detailed guidance to NPPOs for how to select options or display the information processed during the pest risk management stage of the PRA. A simple table such as this one may be a model to follow, or you may find another system is preferable. In this table, the options may be a single measure, such as a specified chemical treatment, or a series of treatments, such as fruit bagging, following by inspection and a surface treatment. Each option is evaluated against the same set of criteria, and those that are acceptable are selected.

The critical things to remember are to:
Consider all possible options, either singly or in combination
Evaluate the possibilities equally
Select the options that will achieve the desired level of protection

In this table, we've summarized the results of the evaluations of each of the previously mentioned four options for phytosanitary measures. They are all effective to varying degrees, though there is some possibility of human error or failure in the options to prohibit certain plant parts or inspect and treat imported plants. To enhance their effectiveness, a combination of measures may be required.

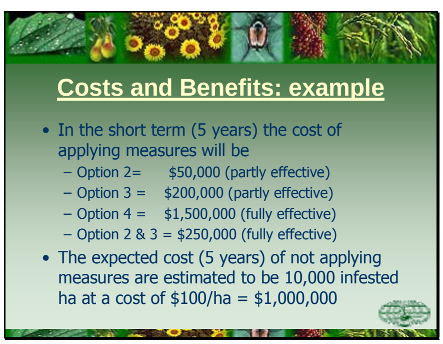
The pest-free area option is considered to be not feasible since the exporting country cannot do it. The other options are all equally feasible.

In terms of efficiency, only options 2 and 3 are very efficient and these, too, have some limitations. Option 4 is considered to be not efficient because of the long time requirement for it to be effective.

Although there is no dollar value associated with the costs for the Pest Fee Area option, there are costs to the industry with this option, since it would not be able to continue importing plants under this option. The costs for the other options are listed as discussed. Option 2 is the lowest cost option and option 4 is the most costly option.

In this simple example, option 1 is considered to be unacceptable since it is not feasible and option 4 is not acceptable because it is too costly. Only options 2 and 3 are effective, feasible and efficient. The differences between the two then come down to their costs and the benefits expected from each. Options 2 and 3 are both potentially acceptable and can be considered as appropriate measures.

Slide 31



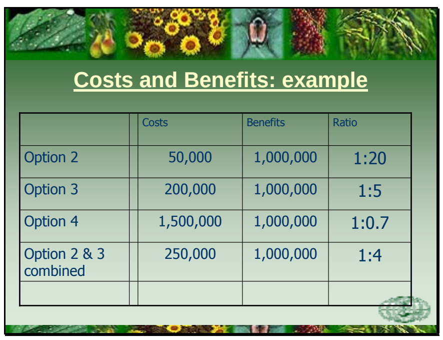
For a five year period, then, we can estimate the costs of applying any of these measures. To implement a requirement based on prohibiting certain plant parts the estimated costs will be $50,000 over five years, with the cautionary note that this measure is only partially effective. The option to inspect and treat imported plants is estimated to cost approximately 200,000 dollars over five years, and it too is only partially effective. The fourth option, post-entry quarantine, will cost an estimated $1.5 million and though this would be a fully effective measures, its costs are very high. By combining options 2 & 3, we have a fully effective measure for an estimated cost of 250,000 dollars.

Based on the earlier pest risk

assessment, we can also estimate the costs of not applying any measures. If this approach is taken, the pest is expected to become established over the 10,000 hectare production area, causing losses of approximately $100 per hectare for a total, over five years, of $1 million. The costs of not doing anything, i.e., a million dollars in this instance, is the benefit of applying measures. By applying measures, we can avoid this million dollar cost.

In order to select an appropriate measure, these costs and benefits should be compared.

Slide 32



	Costs	Benefits	Ratio
Option 2	50,000	1,000,000	1:20
Option 3	200,000	1,000,000	1:5
Option 4	1,500,000	1,000,000	1:0.7
Option 2 & 3 combined	250,000	1,000,000	1:4

In conducting this comparison, we find that options 2 and 3 have the lowest cost-benefit ratio. However, as neither is fully effective alone, they may not be preferred options. A comparison of the cost-benefit ratio for Option 4, the post-entry quarantine treatment, is unacceptably high. In this instance, we find that the costs of the measure outweigh the benefits.

Options 2 and 3 combined, however, provide effective protection at an acceptably low cost-benefit ratio of 1 to 4.

Slide 33

Pest risk management is a complex process and I've only been able to provide you with a brief introduction today. Keep in mind that Stages 2 and 3 of the PRA process, pest risk assessment and pest risk management, go hand-in-hand. When the pest risk assessment is completed and the risk is considered to be unacceptable, the pest risk management stage commences.

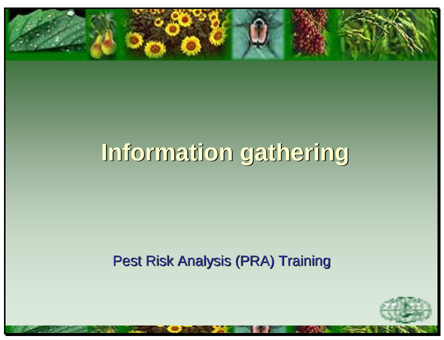
With each mitigation measure that is applied, there is an effect on pest risk. During the evaluation of mitigation measures, it may be necessary to reconsider the pest risk assessment to determine the effect of that measure on overall pest risk. PRA is a very circular process – evaluate the risk – propose a mitigation measure to reduce the risk – evaluate the effectiveness of the proposed measure and re-evaluate the risk.

At the conclusion of the Pest Risk Management Stage, risk mitigation measures will have been identified which will lower the level of risk to an acceptable level and the PRA stops. We've covered a lot of ground today from the conclusion of the pest risk assessment stage, through the identification and evaluation of risk mitigation measures, to the selection of appropriate risk mitigation measures and the conclusions of the PRA.

Information Gathering

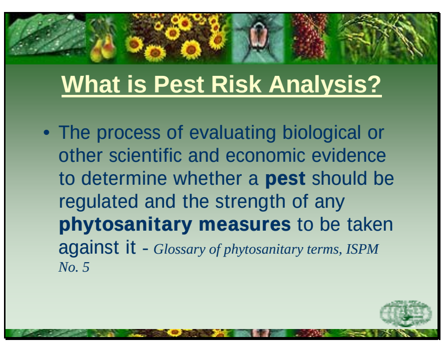
Slide 1

Slide 2



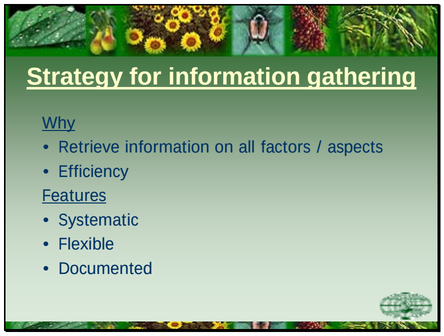
Now we'll talk about information gathering – as we (will find out/have found out) *[depending on timing]* this week information is key to PRA. The more information gathered, the better the quality of your decisions and judgments used in the PRA.

Slide 3



What is Pest Risk Analysis?
Pest Risk Analysis is "the process of evaluating biological or other scientific and economic evidence to determine whether a pest should be regulated and the strength of any phytosanitary measures to be taken against it"

Slide 4



When beginning PRA, a strategy for information gathering is very useful. Why the need for a strategy? Well, information needs to be retrieved in an efficient way. PRA is a multidisciplinary process – Biology, Geography, Economics. Many different disciplines contribute to PRA. Becoming familiar with different sources of information and efficient in retrieving the relevant information and using it in the proper places in the PRA is very important.

A feature of a good strategy is that it is systematic – it helps work through the information gathering in a logical way. A strategy must also be flexible – to be adaptable to avoid collecting redundant, no longer needed, or out of date information.

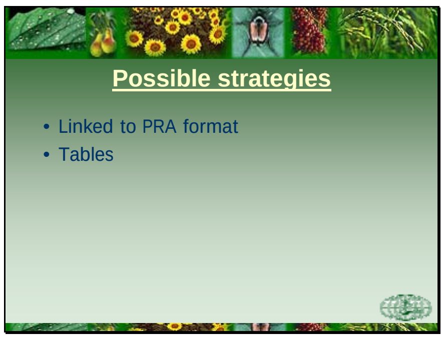
It must be systematic so that all the sources are covered and the needed information is collected, but must also flexible so that time is not wasted and information can be collected at different points along the strategy.

If the strategy is documented then others can learn from the strategy and take up the information gathering. A key skill of the PRA practitioner is to be able to source the appropriate information from the right source in the right time. In a documented strategy, explaining how to get the information helps in this regard. Although documentation is important, it also must be fit for the purpose. Primarily it will be scientists who are familiar with gathering information from literature searches and so on.

Slide 5

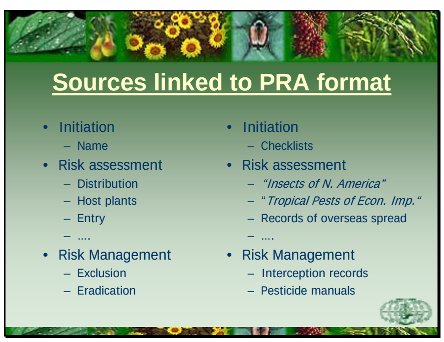
Normally information is collected on a pest or a pathway – either the host or the country – or a policy. Again here we see the three Ps (pest, pathway and policy).

Slide 6



If there is a PRA format, it could link the information gathering to that format. Creating tables of information is also useful.

Slide 7



Now on to sources linked to the PRA format...
On the left hand side we see key components of a PRA: initiation, risk assessment and risk management. Within each key component there are different aspects. Such as distribution, host plants, entry and so on under the risk assessment component.
On the right hand side is possible sources of information that relate to the different parts of the PRA. For example under initiation, when the name of the pest is needed, a checklist could be used. These lists give names and are official, up to date, valid, scientific names with synonyms as well. Older material might contain very useful information but only under synonyms. If synonyms are not also checked, valuable information may be missed.

Under risk assessment as shown here key references might be applicable such as “Insects of North America”. Entry information could be more difficult but records of spread in other areas of the world may be useful and many countries record information on this. Make sure that information sources are fully documented.

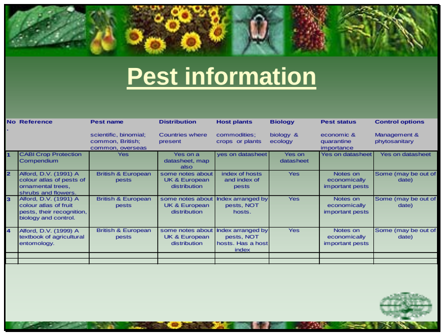
Risk management sources could be interception records or pesticide manuals for possible eradication methods from the PRA or other countries.

Now this aligns the information sources to the PRA format and there will be lots of places where information sources could be used in different areas of a PRA. When just beginning PRAs, collecting information sources and seeing where they fit can help in the development of the strategy.

Slide 8

Another way of organizing information is in a table such as this one. On the left hand side there are different types of information – how it might fit into a PRA. Across the top – pest, pathway- on the host or commodity, or on the country, and then policy. Information sources on each of those Ps (pest, pathway and policy) relating to the categories of information on the left can be put in the table.

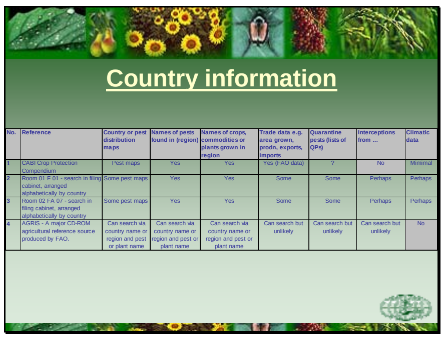
Slide 9



No.	Reference	Pest name scientific, binomial; common, British; common, overseas	Distribution Countries where present	Host plants commodities; crops or plants	Biology biology & ecology	Pest status economic & quarantine importance	Control options Management & phytosanitary
1	CABI Crop Protection Compendium	Yes	Yes on a datasheet, map also	yes on datasheet	Yes on datasheet	Yes on datasheet	Yes on datasheet
2	Alford, D.V. (1991) A colour atlas of pests of ornamental trees, shrubs and flowers.	British & European pests	some notes about UK & European distribution	index of hosts and index of pests	Yes	Notes on economically important pests	Some (may be out of date)
3	Alford, D.V. (1991) A colour atlas of fruit pests, their recognition, biology and control.	British & European pests	some notes about UK & European distribution	Index arranged by pests, NOT hosts.	Yes	Notes on economically important pests	Some (may be out of date)
4	Alford, D.V. (1999) A textbook of agricultural entomology.	British & European pests	some notes about UK & European distribution	Index arranged by pests, NOT hosts. Has a host index	Yes	Notes on economically important pests	Some (may be out of date)

A pest information source table is here – and this is just an example – that contains the source and the type of information it holds. This table collects sources of information and lists references and helps organize them. It describes the types of information that sources provide - pest names, distribution, host plants, the biology of the pest, pest status – particularly of economic importance, and control options.

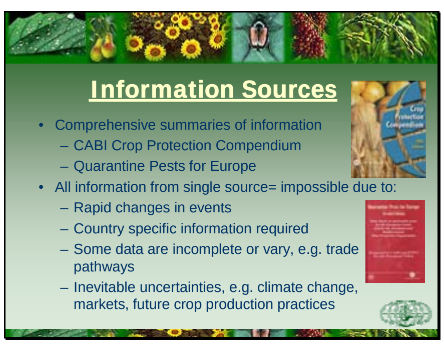
Slide 10



No.	Reference	Country or pest distribution maps	Names of pests found in (region)	Names of crops, commodities or plants grown in region	Trade data e.g. area grown, prodn, exports, imports	Quarantine pests (lists of QPs)	Interceptions from ...	Climatic data
1	CABI Crop Protection Compendium	Pest maps	Yes	Yes	Yes (FAO data)	?	No	Mimimal
2	Room 01 F 01 - search in filing cabinet, arranged alphabetically by country	Some pest maps	Yes	Yes	Some	Some	Perhaps	Perhaps
3	Room 02 FA 07 - search in filing cabinet, arranged alphabetically by country	Some pest maps	Yes	Yes	Some	Some	Perhaps	Perhaps
4	AGRIS - A major CD-ROM agricultural reference source produced by FAO.	Can search via country name or region and pest or plant name	Can search via country name or region and pest or plant name	Can search via country name or region and pest or plant name	Can search but unlikely	Can search but unlikely	Can search but unlikely	No

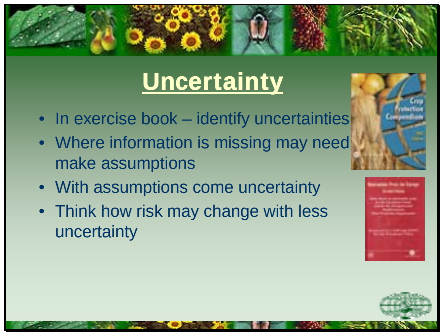
A country information source table is here – similar to what was just shown – it has references and what types of information may need to be collected for a PRA. For example, distribution maps, names of pests found in the country or region, names of crops grown in that country, trade data-export and import types of information, lists of quarantine pests, whether there is information of interceptions, and climatic data. A table like this one compiles information sources so that PRAs can be as complete as possible.

Slide 11



Some common sources are comprehensive summaries such as the CABI Crop Protection Compendium or in Europe – Quarantine Pests for Europe which is a compilation of datasheets. It will be impossible to find a single source for all of the information because of rapid changes in events, and country specific information is required which may change over time. Some data will always be incomplete, e.g. trade pathways or economic injury levels. There are also inevitable uncertainties, e.g. climate change, markets, future crop production practices and so on. Information is dynamic – it is changing. There is therefore a need for a variety of sources.

Slide 12



During the week we have been conducting a PRA in detail of *Thrips* on cut flowers and the threat to citrus and other crops. During the process we have been identifying uncertainties in the exercise book and where information is missing, an assumption might need to be made. When an assumption is made, there is an uncertainty. It might be useful to think how the risk may change if there was less uncertainty. If the risks were to be plotted using a scale of low, medium, high, about each point it could be said with some degree of confidence how much certainty there was. Where high areas of uncertainty are present it might be decided to spend more time looking for more information to reduce uncertainty or that it does not really matter. A high amount of uncertainty about a pest causing a high impact might result in spending time gathering more information to determine whether or not it really is likely to be a high impact. Conversely, perhaps it is an area where there is a low impact and not much uncertainty and thus the current information is acceptable.

Slide 13

This is an international list serve to discuss PRA issues. You can subscribe by sending an e-mail to the following address

Risk Communication

Slide 1

Slide 2

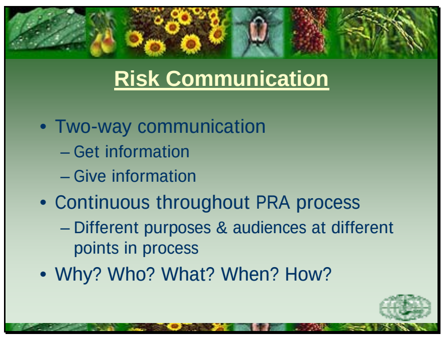
Note to presenter: This is a fairly short, non-technical presentation. It's meant just to give an overview of risk communication, stressing that it occurs throughout the PRA process, rather than at any specific point. It probably works well if kept relatively light-hearted and if participants are encourage to interject ideas throughout. By the fifth day of the course, participants should know each other well and be comfortable with the participatory approach to training. Examples of risk communication should be drawn from the week's work together – the various exercises each involved some form of risk communication, either during the exercise itself, or during the report back to plenary at the end of the exercise.

Points:

We haven't said very much about risk communication all week, but today we'll spend a little time thinking about it. Risk communication is not a discrete stage in PRA. Instead it runs throughout all stages of the PRA and occurs at many levels and in many forms from the beginning of initiation to the conclusion of a PRA.

[If small "prizes", like fridge magnets, buttons or badges, posters or pens, have been distributed throughout the week, make reference to these as examples of risk communication tools that have been used by the originating NPPO(s). If not, ask participants if they can think of examples of risk communications tools used by their NPPO – in addition to little hand-outs like those already mentioned, examples should include web-sites, letters, newspaper ads, radio announcements....]

Slide 3



Risk communication is a two-way street. During risk communication, we both get information and give information.

It is also continuous. There is no single point during the PRA that risk communication should be undertaken. It should happen throughout the process, though the nature of the issues that are discussed and the people that are engaged may differ as the file progresses. Imagine a new PRA request – the first form of risk communication will normally involve the NPPO gathering more basic information about the pest and the values at risk in order to complete Stage 1, the initiation of the PRA. During Stage 2, the pest risk assessment, technical specialists may be engaged to contribute information about the pest and growers might be contacted to both inform them of the PRA that is underway and to get accurate information about the values at risk. Likewise, in Stage 3, experts in pest control, product inspection or shipping might be consulted. And when a conclusion has been reached, further communication with importers, exporters, and other NPPOs will be critical.

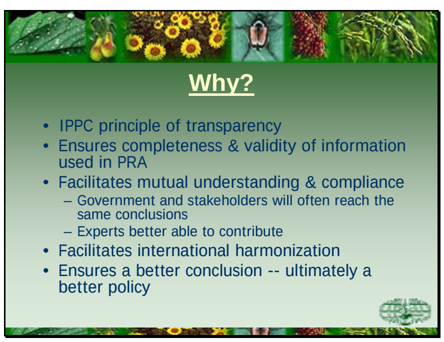
We exchange information of all sorts with many different audiences. We gain and share information about:
why a pest risk assessment is necessary,
why we've come to the conclusions

we've reached,
Why we have selected certain mitigation options

We talk to many different people: who? Scientists, researchers and other experts in pest biology, pest control, economics, agriculture or forestry science, for example
Also importers, exporters, domestic producers of plants or plant products, manufacturers, environmental groups, educators, politicians; there are many people who are potentially affected by our decisions and who can help us formulate good phytosanitary decisions
We also communicate with our counterparts in other NPPOs and with our trading partners

When and how we elect to communicate with others is really an NPPO decision as the degree and extent to which risk communication is necessary varies to some extent from one situation to the next. A highly contentious or uncertain situation will benefit from extensive communication with many varied audiences; a simple and straight-forward file is probably handled quite adequately with a much simpler communications plan

Slide 4



Risk communication is a lot of work. Why would we do it? How does it help?

Well, for starters, by participating in effective risk communication, we ensure that we are respecting the IPPC principle of transparency. WE share information with others about what we know about a pest situation, what we consider to be the factors which make the pest risk acceptable or not, and what measures we have selected for mitigating that risk.

Perhaps even more significantly, risk communication ensures that our PRA is complete, that the information we've used to come to our conclusion is complete, that its correct, that we can defend our position. By communicating throughout the PRA process, we maximize our opportunities to gain valuable information that will contribute to a better PRA.

By sharing information about pest risk, we also facilitate mutual understanding and respect, we ensure better compliance with introduced phytosanitary measures and acceptance of our requirements. Risk communication is a means by which government and non-government stakeholders can exchange information, often coming to the same conclusions in the end. Risk communication, therefore, helps to break down a “them and us” kind of mentality and brings stakeholders, like industry groups, importers or exporters, to a closer understanding of NPPO responsibilities and points of view, and vice versa. By engaging scientists and other experts in the PRA process, they gain a better understanding of the kind of information that is needed in a PRA and they are then better able to contribute meaningfully.

This is true also of communication between NPPOs. Shared information and dialogue during the development and at the conclusion of a PRA contributes to international harmonization and a greater degree of trust and compliance with phytosanitary requirements.

Ultimately, a better PRA, a better conclusion and a better phytosanitary policy. Not a bad outcome from simply talking together!

[*Before going to the next slides, you could ask participants who they might engage in risk communication, when and how. These are the topics of the next couple of slides and examples are given, but its almost certain that participants will have other examples to add, especially if its been an interactive group with lots of participation in the exercises. Remind participants of the week's exercises – which exercises included an element of risk communication? Which did not but would have been improved if there had been more communication involved?*]

Slide 5

So what do we talk about and who do we talk to?

Well, we talk to different people about different things. Some of those people teach us things, and some learn from us.

For example, PRAs are generally conducted by staff members of an NPPO. These are usually biology-trained experts in pest risk analysis, and they may have a wide range of backgrounds and experience. They may deal with very many issues in a given period of time, making it very difficult to be an expert in any particular subject. PRA practitioners, however, quickly become experts in pest risk analysis. And in finding others who are experts in specific subjects.

For example, producers and industry representatives know a great deal about the affected industry groups, the economic and physical environment in which they must work, and about the commodity or commodities that are potentially affected; they know about normal production practices in their sector, including pest control practices, and the normal harvesting, cleaning and packing processes that their products undergo.

Government, university and private researchers know about the pest, its biology, identification, how to find it, how to control it etc.

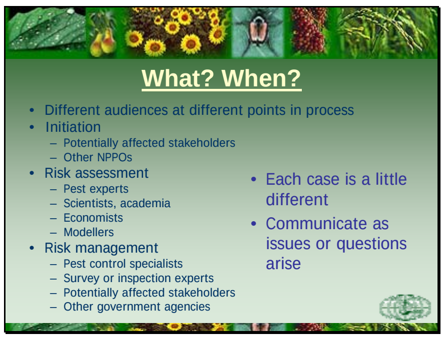
And economists are able to contribute their knowledge and expectations about the potential economic effects of either the pest or any proposed mitigation measures.

It is impossible for any NPPO to have all the expertise about all the possible pests and plants or plant products that might be of interest to them. It is impossible for them to foresee all the implications of a proposed policy, either, so risk communication is essential to developing a good policy

Slide 6

So who do we want to include in our risk communications? The list can be long or short, depending on the NPPO and the issue, but the best starting point is to make a list – include everyone or every group that might have an interest in the subject – people who may have knowledge to contribute or who may be affected by the outcomes. Take the time to be sure you've identified everyone. In the end, the time invested in risk communication will be time well-spent.

Slide 7



Normally, risk communication engages different audiences at different points in the PRA process.

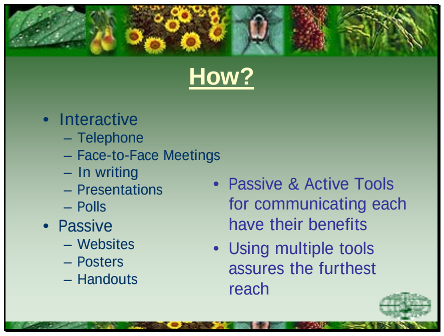
During initiation, we might contact potentially affected stakeholders to tell them we are undertaking a PRA and to seek their input at this early stage. We might also inform other NPPOs and see if any have conducted PRAs on the same subject.

During the risk assessment stage, when more technical information is needed, the list of stakeholders is a little longer and includes experts in many fields – pest experts, economists, experts in predictive modelling

And finally, during risk management, we may need to engage pest control experts, survey or inspection expeorts, other government agencies and other potentially affected stakeholders.

Naturally, these lists are not comprehensive and I am sure there are other audiences that could be included here *[opportunity to solicit input from participants]*

Slide 8



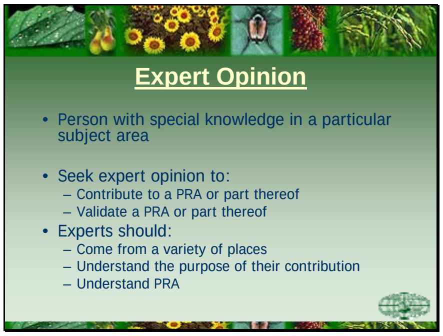
Risk communication need not be a complicated a formal process. The most effective risk communication takes many forms, both passive and active, and takes place in many venues and at various points in the PRA process. As questions arise or decisions are reached, communication of progress so far and next steps is a helpful way of engaging stakeholder input and seeking support or buy-in.

Interactive forms of communication may be personal, as in one-to-one meetings, phone calls or written correspondence, or they may be impersonal and targeted at a wide audience, as in mass-distributed letters, opinion polls or web-based questionnaires that seek input from target audiences.

Passive communication may be an effective means of communicating with a broad audience, or when the intended audience is not well known, for example when trying to reach the general public or individuals with a special interest. Passive forms of communication include web-sites, posters, handouts, even general mail outs in tax bills or utility bills may be an effective way to reach many people with a single message.

There is no single right way or right time to do risk communication. The best bet is to use multiple tools and a variety of forms or opportunities to communicate.

Slide 9



A special form of risk communication is known as expert solicitation, or seeking expert opinion. Expert solicitation is particularly valuable as a means of getting answers to specific technical questions when information is either absent, conflicting or incomplete. Expert opinion may be a useful way of reducing uncertainty in any particular part of a PRA.

An expert is a person with special knowledge in a particular area – there are many kinds of experts – scientists, economists, agrologists, pest control experts, marketing experts, industry experts – and each has a different special knowledge which may be helpful at some point in a PRA>

Expert opinion is generally solicited either to assist in the development of a PRA or to validate a PRA that has already been completed. For example, a panel of experts from different organizations each with knowledge of a particular pest may be gathered and asked to estimate that species potential distribution or the magnitude of its potential impacts in the PRA area. Or they may be asked to evaluate a proposed management strategy that has been developed for that pest.

Experts may come from a wide variety of places, depending on the nature of their expertise they may be found in government organizations, academic institutions, business enterprises, volunteer organizations and special interest groups. To be best able to contribute their expertise, experts should understand the purpose of the contribution. They should have a general knowledge of PRA and, therefore, understand what kind of information is particularly useful.

When plum pox virus was first found in Canada in 2000, a foreign expert panel was formed and called upon to provide advice based on their experience with the virus in their homelands. They were provided with information and tours of the infested area in Canada, and using this new information and their knowledge of the virus in other areas, they provided advice and information that contributed to Canada's plum pox virus response plan, including survey design, diagnostic procedures and eradication methods.

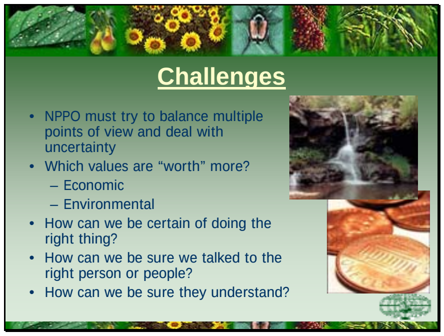
The use of expert opinion can be a valuable form of risk communication which contributes to the development of a sound PRA upon which to base phytosanitary policy.

Slide 10

Regardless of the form of risk communication that is selected, there are a few key points to keep in mind.

Remember that risk communication is a continuous activity; it does not occur in discrete points in the PRA process
Its also two-way – be prepared to both provide and receive information
Seek out experts – find people who can provide you with the information that you need; sometimes they may even tell you what questions you should be asking!
Explain PRA to the people you are talking to; without understanding the reason for your seeking their opinion or how their information will be used, they will be unable to help you to their fullest ability
Once you've explained what you need and what you know, give your audience an opportunity to contribute – listen to their advice, consider their information carefully
And let them know you've listened and that their information is of value to you; this seems a small point, but its important
And, of course, wherever possible, integrate the information you've collected into your PRA;
PRA is a complex process that requires many kinds of information from many sources; expert solicitation and other forms of risk communication provide an opportunity to gather information from a wider variety of sources than is usually found in an NPPO

Slide 11



Risk communication, of course, also presents challenges. If you seek opinions from a variety of sources, you will no doubt get a variety of opinions and points of view. An NPPO must try to balance these multiple viewpoints and deal with the uncertainty that is inherent in PRA. It must also balance different values – economic, social, cultural, environmental – each nation has its own unique set of values. It is up to the NPPO to conduct its PRAs and formulate its decisions in accordance with the principles of the IPPC set in the context of national values.

There will always be uncertainty and there will probably always be more people that could be contacted, or people who should be contacted again. How can we be certain of doing the right thing? Of talking to the right people? Of ensuring that these people understand what it is we are telling them?

These are all questions that NPPOs ask themselves and strive to answer by means of risk communication. Each is a little easier answered when risk communication is integrated into the PRA process and used at every opportunity throughout the development of the PRA and at its completion.

Even though risk communication opens an NPPO to some challenges, like different points of views or competing values, it is still worth doing for the reasons given earlier – more complete information, greater scientific integrity, improved understanding among the stakeholders of different points of view, greater compliance, enhanced harmonization.... the benefits are many.