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   a) How big of a problem is it?
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i) USA
   • ~50,000 plant species have been introduced into US
5) **Management**  
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     Great Basin: cheatgrass dominates >26,000 sq miles with >97,000 sq miles at risk
   • **Aliens invade ~700,000 ha per year**
     Purple loosestrife is ~115,000 ha per year (almost exclusively wetlands) (16%)
     Melaleuca ~11,000 ha per year in Everglades
5) Management
   a) How big of a problem is it?

   ii) International
       • >3% of earth’s terrestrial surface is dominated by aliens
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ii) International
   • >3% of earth’s terrestrial surface is dominated by aliens
     
     **But not uniform:**
     
     Very cold climates (polar regions, high elevations) have very few
     
     Closed canopy tropical forests have very few
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   • >3% of earth’s terrestrial surface is dominated by aliens
     **But not uniform:**
     - Very cold climates (polar regions, high elevations) have very few
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     **Islands typically have worst problems**
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   • >3% of earth’s terrestrial surface is dominated by aliens
     But not uniform:
       Very cold climates (polar regions, high elevations) have very few
       Closed canopy tropical forests have very few
       Islands typically have worst problems
     But essentially every ecosystem has at least a few invasives
5) **Management**
   a) How big of a problem is it?

ii) **International**
   • USA: 23% aliens
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ii) International
   • USA: 23% aliens
   • Britain: 1169 naturalized aliens and 1515 natives (44%)
5) Management
   a) How big of a problem is it?

ii) International
   • USA: 23% aliens
   • Britain: 56% aliens
   • South African fynbos: ~8,600 native plant species, but up to 90% of natives are lost in areas with invasives
5) **Management**
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ii) **International**
   - USA: 23% aliens
   - Britain: 56% aliens
   - South African fynbos: up to 90% aliens
   - **Germany:**

![Graph showing the number of species over time with labels for indigenous species, total of all species, and other categories.](image)
5) Management
   a) How big of a problem is it?

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   • USA: 23% aliens
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   • South African fynbos: up to 90% aliens
   • Germany:
     Today: ~3,300 plant species
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   • Britain: 56% aliens
   • South African fynbos: up to 90% aliens
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     Today: ~3,300 plant species
     2850 "natives" (~7000 BC) (86%)
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   - **Germany:**
     Today: ~3,300 plant species
     2850 “natives” (~7000 BC) (86%)
     **First set of invasives:** 165 species (5%)
     Added w/o negative effects on natives
     Most from S & SE Europe
     Primarily due to land use changes
     (ag, pasture, etc.)
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     **New aliens:** ~12,000 species introduced over last 500 years
     Most from North America & east Asia
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     - **New aliens:** ~12,000 species introduced over last 500 years
       - Most from North America & east Asia
       - **Most not successful**
       - But 315 species were successful (9%)
5) **Management**
   
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     Most not successful
     But 315 species were successful (9%)
     **Unlike old aliens, new aliens have displaced other species**
     10 old aliens extinct
     50 old aliens endangered
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        Most not successful
        But 315 species were successful (9%)
     **Unlike old aliens, new aliens have**
        **displaced other species**
        47 natives extinct
        850 natives endangered
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- South African fynbos: up to 90% aliens  
- Germany: 14% aliens  
- **New Zealand:** Plants  
  - 43% of all dicots are aliens  
  - 38% of all monocots  
  - 50% of all conifers  
  - 15% of all ferns  
  **Total = 1,623 aliens (41%)**
5) **Management**
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     Plants: 1,623 aliens
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**ii) International**

- **USA:** 23% aliens
- **Britain:** 56% aliens
- **South African fynbos:** up to 90% aliens
- **Germany:** 14% aliens
- **New Zealand:** 41% aliens
- **Chile:** 1st 2 columns are origin

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<td></td>
<td>&lt;1900 N (%)</td>
<td>≥1900 N (%)</td>
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     Majority from mediterranean climates

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*Also shows when arrived*

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Largest #: colonial

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Also shows when arrived
Largest #: colonial
But last 100 years
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*Also shows when arrived*

Largest #: colonial
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**Invasive rate is accelerating**
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     Accelerating invasion rate

Growth form

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Percentage: 50.6, 3.9, 37.5, 14.1
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**Growth form**
\(\frac{1}{2}\) are annual herbs
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**Accelerating invasion rate**

**Growth form**

½ are annual herbs

Followed closely by perennial herbs

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   b) Prevent entry

i) **Vectors**
5) Management
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i) Vectors
   • Natural modes of introduction are rare
     Long distance dispersal is rare
     For most wind-dispersed species, dispersal beyond 40-60 m of
     the parent is virtually zero.
5) Management
   b) Prevent entry

i) Vectors
   • Natural modes of introduction are rare
   Long distance dispersal is rare, but it does occur
   Hawaii:
      Prior to Polynesian colonization, 1 plant species per 100,000 years
5) Management
   b) Prevent entry

i) Vectors
   • Natural modes of introduction are rare
     Long distance dispersal is rare, but it does occur
     Hawaii:
       Prior to Polynesian colonization, 1 plant species per 100,000 years
       During Polynesian colonization, 1 plant species per 50 years
5) Management  
   b) Prevent entry

i) Vectors  
   • **Natural modes of introduction are rare**  
     Long distance dispersal is rare, but it does occur  
     Hawaii:  
     Prior to Polynesian colonization, 1 plant species per 100,000 years  
     During Polynesian colonization, 1 plant species per 50 years  
     **Post-European settlement, 22 plant species per year**
5) Management
   b) Prevent entry

i) Vectors
   • Natural modes of introduction are rare
   • **Humans are the principal vector**

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**Fig. 1.** Some invaders have widely separated new ranges, the products of repeated human dispersal and cultivation. For example, the shrub *Lantana camara* was carried transoceanically throughout the 19th and early 20th century to many subtropical and tropical locales where it has proliferated. Years refer to dates of introduction in widely separated locales (Cronk and Fuller 1995).
5) Management
   b) Prevent entry

i) Vectors
   • Natural modes of introduction are rare
   • **Humans are the principal vector**
     ↑ trade & tourism → ↑ invasions
5) Management
   b) Prevent entry

i) Vectors
   • Natural modes of introduction are rare
   • Humans are the principal vector
   • Higher potential for invasive from intentionally introduced species
5) Management
   b) Prevent entry

i) Vectors
   • Natural modes of introduction are rare
   • Humans are the principal vector
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5) Management
   b) Prevent entry

i) Vectors
   • Natural modes of introduction are rare
   • Humans are the principal vector
   • Higher potential for invasive from intentionally introduced species
5) **Management**
   b) Prevent entry

i) **Vectors**
   - Natural modes of introduction are rare
   - Humans are the principal vector
   - **Higher potential for invasive from intentionally introduced species**

![Pie chart showing:
- **LANDSCAPE 85%**: Aesthetics, wildlife habitat, soil protection
- **AGRICULTURE 14%**: Food, fiber, fuel
- **ACCIDENTAL 1%**: Contamination]
5) **Management**
   b) Prevent entry

i) **Vectors**
   - Natural modes of introduction are rare
   - Humans are the principal vector
   - Higher potential for invasive from intentionally introduced species
   - **For US: Europe historically primary source**
5) Management
   b) Prevent entry

i) Vectors
   • Natural modes of introduction are rare
   • Humans are the principal vector
   • Higher potential for invasive from intentionally introduced species
   • For US: Europe historically primary source, but Asia and especially China are becoming major sources
5) Management
   b) Prevent entry

i) Vectors
   • Natural modes of introduction are rare
   • Humans are the principal vector
   • Higher potential for invasive from intentionally introduced species
   • For US: Europe historically, but Asia/China becoming major sources
   • Higher potential for invasive for repeated introductions
5) **Management**
   b) Prevent entry

ii) **Quarantine**
   • “Ounce of prevention”
5) **Management**  
   b) Prevent entry

ii) **Quarantine**  
   • “Ounce of prevention”  
   • 4 strategies to screen species:  
     1. “Dirty list” approach – species can be admitted unless proven to be invasive and thus specifically prohibited
5) Management
   b) Prevent entry

ii) Quarantine
   • “Ounce of prevention”
   • 4 strategies to screen species:
     1. “Dirty list” approach
     2. “Clean list” approach – species are prohibited unless proven to be NON-invasive and specifically listed as “clean”
5) **Management**
   b) Prevent entry

ii) **Quarantine**
   • “Ounce of prevention”
   • 4 strategies to screen species:
     1. “Dirty list” approach
     2. “Clean list” approach
     3. **Test each species before a decision regarding entry is made**
5) Management
   b) Prevent entry

ii) Quarantine
   • “Ounce of prevention”
   • 4 strategies to screen species:
     1. “Dirty list” approach
     2. “Clean list” approach
     3. Test each species
     4. Estimate invasive potential before a decision regarding entry is made
5) Management
   b) Prevent entry

iii) Legal aspects
   (1) International treaties
5) **Management**  
   b) Prevent entry

iii) **Legal aspects**  
   (1) International treaties  
   • **International Plant Protection Convention (IPPC)**  
5) Management
   b) Prevent entry

iii) Legal aspects
(1) International treaties
• International Plant Protection Convention (IPPC)
  Recognizes “the usefulness of international cooperation in
  controlling pests of plants and plant products and in preventing
  their spread, and especially their introduction across national
  boundaries”
5) **Management**
   b) Prevent entry

iii) **Legal aspects**
   (1) International treaties
   - **International Plant Protection Convention (IPPC)**
     1951 adopted. 1952 in force. 1987 amended. US ratified in 1972. Recognizes “the usefulness of international cooperation in controlling pests of plants and plant products and in preventing their spread, and especially their introduction across national boundaries”
     **Countries** “have full authority to regulate the entry of plants and plant products”
5) Management
   b) Prevent entry

iii) Legal aspects
(1) International treaties
• **International Plant Protection Convention (IPPC)**
  Recognizes “the usefulness of international cooperation in
  controlling pests of plants and plant products and in preventing
  their spread, and especially their introduction across national
  boundaries”

  **Countries** “have full authority to regulate the entry of plants and
  plant products”, but must “minimize interference with
  international trade”
5) Management
   b) Prevent entry

iii) Legal aspects
(1) International treaties
   • International Plant Protection Convention (IPPC)
     Recognizes “the usefulness of international cooperation in
     controlling pests of plants and plant products and in preventing
     their spread, and especially their introduction across national
     boundaries”
     Countries “have full authority to regulate the entry of plants and
     plant products”, but must “minimize interference with
     international trade”

   **Individual countries establish plant protection offices** with
   authority for quarantine, risk analysis, etc. to prevent
   establishment & spread of aliens that directly or indirectly are
   pests of plants
5) Management
   b) Prevent entry

iii) Legal aspects
(1) International treaties
• **International Plant Protection Convention (IPPC)**
  Recognizes “the usefulness of international cooperation in controlling pests of plants and plant products and in preventing their spread, and especially their introduction across national boundaries”
  Countries “have full authority to regulate the entry of plants and plant products”, but must “minimize interference with international trade”
  Individual countries establish plant protection offices with authority for quarantine, risk analysis, etc. to prevent establishment & spread of aliens that directly or indirectly are pests of plants

**Imports and exports involve “phytosanitary” certificates:**
  “plants or plant products ... are considered to be free from quarantine pests, and practically free from other injurious pests”
5) Management
   b) Prevent entry

iii) Legal aspects
(1) International treaties
   • International Plant Protection Convention (IPPC)
   • Convention on Biological Diversity (CBD)
5) **Management**
   
b) Prevent entry

iii) **Legal aspects**
(1) International treaties
   
   • **International Plant Protection Convention (IPPC)**
   
   • **Convention on Biological Diversity (CBD)**

   **Objectives of CBD** include “the conservation of biological diversity” and “the sustainable use of its components”
5) Management
   b) Prevent entry

iii) Legal aspects
(1) International treaties
• International Plant Protection Convention (IPPC)
• Convention on Biological Diversity (CBD)
   Objectives of CBD include “the conservation of biological diversity” and “the sustainable use of its components”
   Article 8(h) requires countries to “as far as possible and as appropriate” “prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species”
5) Management
   b) Prevent entry

iii) Legal aspects
(1) International treaties
   • International Plant Protection Convention (IPPC)
   • Convention on Biological Diversity (CBD)
   • **World Trade Organization (WTO)**
     1995 organized and adopted. US member from beginning. Established to liberalize world trade opportunities
     >140 countries are members
5) Management
   b) Prevent entry

iii) Legal aspects
(1) International treaties
   • International Plant Protection Convention (IPPC)
   • Convention on Biological Diversity (CBD)
   • **World Trade Organization (WTO)**
     1995 organized and adopted. US member from beginning.
     Established to liberalize world trade opportunities
     >140 countries are members
     Established trade rules; discusses and adjudicates trade
     disputes. Covers topics such as market access (imports),
     export subsidies, domestic price supports, &
     sanitary/phytosanitary measures
5) Management
   b) Prevent entry

iii) Legal aspects
   (1) International treaties
       • International Plant Protection Convention (IPPC)
       • Convention on Biological Diversity (CBD)
       • **World Trade Organization (WTO)**
         1995 organized and adopted. US member from beginning.
         Established to liberalize world trade opportunities
         >140 countries are members
         Established trade rules; discusses and adjudicates trade disputes.
         Covers market access (imports), export subsidies, domestic
         price supports, & sanitary/phytosanitary measures
         **Annex B indicates that when a country proposes a domestic
regulation to restrict an import, that country must notify
other WTO members of the restriction along with why
imposing the restriction if the regulation may have a
“significant effect” on other WTO members**
5) **Management**
   b) Prevent entry

iii) **Legal aspects**
(1) International treaties
   • International Plant Protection Convention (IPPC)
   • Convention on Biological Diversity (CBD)
   • **World Trade Organization (WTO)**
     Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement)
5) Management
   b) Prevent entry

iii) Legal aspects
(1) International treaties
   • International Plant Protection Convention (IPPC)
   • Convention on Biological Diversity (CBD)
   • World Trade Organization (WTO)
     Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement)
     1994 adapted. 1995 in force along with WTO agreement.
5) Management
   b) Prevent entry

iii) Legal aspects
(1) International treaties
   • International Plant Protection Convention (IPPC)
   • Convention on Biological Diversity (CBD)
   • World Trade Organization (WTO)
     Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement)
     1994 adapted. 1995 in force along with WTO agreement.
     Provides uniform interpretation of the measures governing safety & health regulations for plants & animals as they may affect international trade
5) Management
   b) Prevent entry

iii) Legal aspects
(1) International treaties
   • International Plant Protection Convention (IPPC)
   • Convention on Biological Diversity (CBD)
   • World Trade Organization (WTO)
     Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement)
     1994 adapted. 1995 in force along with WTO agreement.
     Provides uniform interpretation of the measures governing safety & health regulations for plants & animals as they may affect international trade
     Allows WTO members to restrict movement or entry of pests that pose threats to human, animal, or plant life
5) **Management**
   b) Prevent entry

**iii) Legal aspects**
(1) International treaties
   - International Plant Protection Convention (IPPC)
   - Convention on Biological Diversity (CBD)
   - **World Trade Organization (WTO)**
     Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement)
     1994 adapted. 1995 in force along with WTO agreement.
     Provides uniform interpretation of the measures governing safety & health regulations for plants & animals as they may affect international trade
     Allows WTO members to restrict movement or entry of pests that pose threats to human, animal, or plant life, **but must be based on scientific information**
5) Management
   b) Prevent entry

iii) Legal aspects
(1) International treaties
• International Plant Protection Convention (IPPC)
• Convention on Biological Diversity (CBD)
• World Trade Organization (WTO)
   Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement)
   1994 adapted. 1995 in force along with WTO agreement.
   Provides uniform interpretation of the measures governing safety & health regulations for plants & animals as they may affect international trade
   Allows WTO members to restrict movement or entry of pests that pose threats to human, animal, or plant life, but must be based on scientific information and is subject to WTO notification and adjudication
5) Management
   b) Prevent entry

iii) Legal aspects
(2) USA
   • Discussed at beginning of class
     Plant Protection Act of 2000
     Executive Order 13112 (1999)
5) Management
   b) Prevent entry

iii) Legal aspects
(2) USA
   • Discussed at beginning of class
     Plant Protection Act of 2000
     Executive Order 13112 (1999)
   • **Animal and Plant Health Inspection Service (APHIS)**
     Responsible for preventing entry of pests through human-mediated pathways
5) Management
   b) Prevent entry

iii) Legal aspects
(2) USA
   • Discussed at beginning of class
     Plant Protection Act of 2000
     Executive Order 13112 (1999)
   • Animal and Plant Health Inspection Service (APHIS)
     Responsible for preventing entry of pests through human-mediated pathways
     Regulates import of commodities, plants, etc. that might harbor pests
5) Management
   b) Prevent entry

iii) Legal aspects
(2) USA
   • Discussed at beginning of class
     Plant Protection Act of 2000
     Executive Order 13112 (1999)
   • Animal and Plant Health Inspection Service (APHIS)
     Responsible for preventing entry of pests through human-mediated pathways
     Regulates import of commodities, plants, etc. that might harbor pests
     **Agents at seaports, borders, airports intercept restricted items**
     Food carried by tourists
     Contaminants in commodities, packing materials, shipping containers
5) Management
   b) Prevent entry

iii) Legal aspects
(2) USA
   • Discussed at beginning of class
     Plant Protection Act of 2000
     Executive Order 13112 (1999)
   • Animal and Plant Health Inspection Service (APHIS)
     Responsible for preventing entry of pests through human-mediated pathways
     Regulates import of commodities, plants, etc. that might harbor pests
     Agents at seaports, borders, airports intercept restricted items
     Food carried by tourists
     Contaminants in commodities, packing materials, shipping containers
     In 1999: ~2 million interceptions which prevented entry of ~53,000 plant pests
5) Management
   b) Prevent entry

iii) Legal aspects
(2) USA
   • Discussed at beginning of class
     Plant Protection Act of 2000
     Executive Order 13112 (1999)
   • Animal and Plant Health Inspection Service (APHIS)
     Responsible for preventing entry of pests through human-mediated pathways
     Regulates import of commodities, plants, etc. that might harbor pests
     Agents at seaports, borders, airports intercept restricted items
     Food carried by tourists
     Contaminants in commodities, packing materials, shipping containers
     In 1999: ~2 million interceptions which prevented entry of ~53,000 plant pests
     But can only examine <2% of the cars, trucks, ships, airplanes that bring people & products to US
5) Management
   b) Prevent entry

iii) Legal aspects
(2) USA
   • Discussed at beginning of class
     Plant Protection Act of 2000
     Executive Order 13112 (1999)
   • Animal and Plant Health Inspection Service (APHIS)
     Responsible for preventing entry of pests through human-mediated pathways
     Regulates import of commodities, plants, etc. that might harbor pests
     Agents at seaports, borders, airports intercept restricted items
     Inspections for prohibited items (“dirty list”)
5) Management
   b) Prevent entry

iii) Legal aspects
(2) USA
   • Discussed at beginning of class
     Plant Protection Act of 2000
     Executive Order 13112 (1999)
   • Animal and Plant Health Inspection Service (APHIS)
     Responsible for preventing entry of pests through human-mediated pathways
     Regulates import of commodities, plants, etc. that might harbor pests
     Agents at seaports, borders, airports intercept restricted items
     Inspections for prohibited items (“dirty list”) and based on risk assessment
     What is possibility that pests are contaminants in imports or on person?
     What is the economic or environmental damage possibilities?