FY 2004 Indiana Cooperative Agricultural Pest Survey (CAPS) Annual Accomplishment Report

Year: 2004
State: Indiana
Agency: Indiana Department of Natural Resources

Name of State Survey Coordinator (SSC):

Dr. Christopher M. F. Pierce
Purdue University
Department of Entomology
Room 131, Smith Hall
901 West State Street
West Lafayette, Indiana 47907
Telephone: (765) 494-9522
Facsimile: (765) 494-0535
E-mail: cpierce@purdue.edu

State Survey Committee Members:

Name	Organization	Discipline
Dr. Christopher Pierce	Purdue University	State Survey Coordinator
Dr. Robert Waltz, SPRO	Indiana Department of Natural Resources	Entomology/ Regulatory Science
Gary Simon, SPHD	USDA APHIS PPQ	Regulatory Science
Dr. Steve Yaninek	Purdue University	Biological Control/ Invasive Species
Phil Marshall	Indiana Department of Natural Resources	Forest Health
Cloyce Hedge	Indiana Department of Natural Resources	Plant Ecology/ Identification
James Carroll	USDA APHIS PPQ	Forest Health
Jim Pheasant	CERIS	NAPIS
Gail Ruhl	Purdue University	Plant Disease Diagnostics
Dr. Karen Rane	Purdue University	Plant Pathology
Dr. Cliff Sadof	Purdue University	Ornamental Pests
Dr. Chris Oseto	Purdue University	Entomology
Dr. Raymond Martyn	Purdue University	Botany/ Plant Pathology
Dr. Peter Hirst	Purdue University	Horticulture

FY 2004 Indiana Cooperative Agricultural Pest Survey (CAPS) Annual Accomplishment Report

Cooperative Agreement Representative and State Plant Regulatory Official:

Dr. Robert D. Waltz
Indiana Department of Natural Resources
Division of Entomology and Plant Pathology
402 West Washington, Room W-290
Indianapolis, Indiana 46204
Telephone: (317) 232-4120
Facsimile: (317) 232-2649
E-mail: bwaltz@dnr.state.in.us

State Plant Health Director:

Gary Simon
USDA APHIS PPQ
120 Professional Court, Suite D
Lafayette, Indiana 47905
Telephone: (765) 446-0267
Facsimile: (765) 446-8274
E-mail: Gary.W.Simon@aphis.usda.gov

FY 2004 Indiana Cooperative Agricultural Pest Survey (CAPS) Annual Accomplishment Report

Table of Contents **Page**

FY 2004 Indiana Cooperative Agricultural Pest Survey (CAPS) Annual Accomplishment Report

Indiana CAPS Committee Narrative – Meeting dates, attendees, agenda, etc.

On January 13, 2004, Dr. Christopher Pierce assumed the position of the Indiana CAPS State Coordinator.

Three CAPS State Survey Committee meetings occurred during the reporting period. The first meeting was held in West Lafayette, Indiana on February 24, 2004. Introductions to the CAPS State Survey Committee occurred and discussed upcoming surveys for Fiscal Year 2004. The second State Survey Committee meeting occurred on May 6, 2004 in West Lafayette, Indiana. Discussions of the FY 2005 CAPS surveys and educational projects occurred at this time. The final CAPS State Survey Committee occurred on June 17, 2004 in West Lafayette, Indiana. At this time, development of the exotic invasive pests of concern to the state of Indiana occurred as well as the discussion of the development of area wide survey programs for the Midwest Region. The Indiana CAPS State Survey Steering Committee met on September 22, 2004 to discuss a review of the survey season to date.

Minutes for Indiana CAPS Committee Meeting (02-24-04)

Attendance:

Jim Pheasant, CAPS	Bill Smith, Lilly AG	Tonya Byrd, Botany Bus. Office
Gail Ruhl, BTNY	Karen Rane, BTNY	Julie Golod, CAPS
Cliff Sadof, ENTM	Jim Carroll, USDA-APHIS	Phil Marshall, DNR-Forestry
Gary Simon, APHIS-PPQ	Christopher Pierce, CAPS	Deb Dimmitt, ENTM
Nikki Kubly, ENTM	Cherise Hall, Ag Sponsored Program Services	
Steve Yaninek, ENTM	Bob Waltz, DNR	Chris Oseto, ENTM
Cloyce Hedge, DNR	Peter Hirst, HORT	

Review of Budget and Financial Protocols:

- Facilitated by Steve Yaninek
- Gary Simon stated that PPQ still had outstanding billing for 2003
- Deb Dimmitt clarified that we still had orders coming in and the orders can not be paid until the are received
- If new budgets are received, they go to the business office first (*ASAP)
- Typically a 3-6 week turn around

2004 CAPS Work Plans:

- Graduate Student Work (Chris Oseto)
  - Chris Oseto stated that Anne Radavich is continuing her pathway analysis
  - She is looking at common attributes of invasive species
  - Risk assessment using the Monte Carlo Simulation and data is from North Carolina
- Sudden Oak Death Survey (Karen Rane, Gail Ruhl, Bob Waltz)
  - Gail Ruhl informed us that they are increasing the sample size 4X after meeting with Bob Waltz
  - Question was raised about $25,000.00 for the Federal SOD Survey
  - P&PDL is running at capacity due to staff
  - Possibility of fall survey work
- Wood Boring Beetle Survey (James Carroll, Christopher Pierce)
  - Working with DNR
  - State is divided into 4 regions/ Purdue responsible for 1
  - Purdue has 8 sites in central Indiana
  - Begins early March/ Serviced every 2 weeks until September

- Old Bollworm Survey (Christopher Pierce)
    - 6 Counties (Ag. Exp. Stations) throughout Indiana
    - Late June/ Service twice a month for 4 months
- State Survey Programs
    - Gypsy Moth (IDNR, USDA APHIS PPQ, USDA Forest, Dept. of Interior)
    - Emerald Ash Borer (Division of Forestry, Entomology, and Plant Pathology)
    - Pine Shoot Beetle Survey (USDA APHIS PPQ)
    - Exotic Bark Beetle Survey (USDA APHIS PPQ)
        - 2 Tone Chevy is added to survey
        - Borders Missouri and Illinois
    - IPSAWG (Invasive Plant Species Assessment Working Group)
    - USDA APHIS PPQ will draw and submit samples for karnal bunt of wheat
    - Emergency detection and monitoring of other new exotic pests and diseases that my arise this year

    Supplementary Surveys
    - Phil Marshall stated that the Indiana Forest Service will be doing moderate risk hexagon surveys this summer for SOD
        - This survey will focus on the forest habitat of production nurseries
        - Also, a second survey out of Virginia will focus on determining background *Phytophthora* species
    - Cloyce Hedge stated that IPSAWG will be having a survey coastal program around Lake Michigan
        - They will be collecting Lepidoptera pests (native pests)
        - Non-target surveys of state properties as well
        - Steve Yaninek suggested samples should go to Arwin to be housed in the collection for reference

CAPS Issues from the Committee:

- Created a list of issues and objectives for the CAPS Program, Christopher Pierce will prioritize
    - EAB and ALB Surveys have no lures and require trained individuals to survey
    - Contact State to State Work Group (SSC)
    - Training Program to look for EAB (Ellis, Sadof)
    - Newsletter or Webpage for CAPS by commodity or crops or pathway (SSC)
    - Yearly wish list (As objectives come up)
    - E.D.E.N. = get list for first responders
    - Regionalization (Steering Committee)
    - Prioritize List (Steering Committee)
    - Outreach (Mullis and Ellis)
    - Research on CAPS data for Graduate Students (Steering Committee and Dept. of ENTM)
    - N.E.O.N. (Steve Yaninek)
    - Need for trained entomologists and plant pathologists for forest surveys
- Communication
    - Communication is essential
    - Christopher Pierce will contact via e-mail or by phone
- Outreach
    - Steve Yaninek talked about Outreach and Regionalization
    - What are we focusing on, are we missing anything
    - Commodities
    - What does Purdue take a lead on with our CAPS Program?
    - Are there any Pathways or Taxa Purdue should focus on?

- Future Opportunities
  - Contact Steve Cain of E.D.E.N. for list of organizations that may act as First Responders
- Committee Membership
  - Should broaden to encompass all areas
  - Memberships may include Industry, E.D.E.N, The Nature Conservatory, an Aquatic Nuisance expert, someone from Animal Science
- Meetings
  - Suggested 2 or more meetings per year for the whole CAPS Committee
  - A planning meeting in May
  - An end of the season meeting in November to discuss what we found and future considerations
  - Christopher Pierce will contact about making smaller work groups to focus on pathways or insects

How to Proceed:

- Jim Pheasant stated that the Eastern Region Guidelines and National Pest List will be out the first week of March
- Christopher Pierce will then disseminate the material

NEXT MEETING = Thursday, May 6th, 2004 from 1:00 to 4:00 p.m.

FY 2004 Indiana Cooperative Agricultural Pest Survey (CAPS) Annual Accomplishment Report

<u>Minutes for Indiana CAPS Committee Meeting (05-06-04)</u>

Purpose:
To discuss and plan FY 2005 Budget

Attendance:

Christopher Pierce, CAPS	Gary Simon, APHIS-PPQ
Jim Carroll, APHIS-PPQ	Jodie Ellis (filling in for Cliff Sadof), ENTM
Chris Oseto, ENTM	Ray Martyn, BTNY
Gail Ruhl, BTNY	Karen Rane, BTNY
Steven Yaninek, ENTM	Jim Pheasant, NAPIS
Nick Masters, NAPIS	Julie Golod, NAPIS

Current Issues:

- <u>IDNR</u>: Quarantine was placed on the Giant African Land Snail in Indiana.
- <u>IDNR</u>: Gypsy Moth sprayings are being scheduled. At the time of the meeting, a court injunction was filed against the aerial application of *Bt* in Elkhart County. Also, in Fort Wayne, the mayor was against the spraying of *Bt.*
- <u>Gary Simon</u>: Additional $35,000.00 for Sudden Oak Death (SOD) for 2004; also, Sudden Oak Death samples in Indiana were presumptive positives. Two more tests were run and tested negative. Samples were sent to Beltsville, Maryland for negative/positive confirmation. To date: samples were negative.
- <u>Jodie Ellis</u>: Emerald Ash Borer (EAB) in Jellystone Park, Steuben County; as of May 20th, 210 ash trees will be removed, this entails a ¼ mile circle around infested trees. Larvae and pupae were found in trees. Ash trees that are asymptomatic of EAB damage were also infested. Current infestation at site may be up to 3 years are more. Deforestation of ash trees will represent a 1-mile delimiting removal. *Note: In East Lansing, Michigan 100,000 ash trees are marked to be cut down. To date: ash trees were removed.

FY 2005 Budget:

- We will be resubmitting the survey plans for 2004 for FY 2005 due to the same pests being on 2004 on 2005.
- A major problem that the CAPS Committee each year has to deal with is the lists of invasive species that the National and Eastern Region have given to us for the new fiscal year. The majority of species on the list are not of major concern to Indiana. Case in point is that there are at least 7 invasive pests of citrus on the National list; citrus as you may know is not a major crop in Indiana.
- Steve Yaninek has proposed that the Indiana CAPS Committee be proactive to this cause. Due to increased funding for the CAPS program, we believe Indiana can help change the current lists in two ways.

    1. The Indiana CAPS program will develop a state strategic plan. Under this idea we propose to develop specific Top 10 Lists of Invasive Insect, Plant, and Plant Pathogens, and Biothreat agents for Indiana. These lists of pests need to be developed by you the committee members. I need you in your expertise field to e-mail me what you believe are the top 10 invasive pests in your area. (Example: If I were a weed specialist, I would e-mail myself the top 10 invasive weeds that will affect Indiana. If they are Biothreat, add them to the Biothreat agent lists.) Please e-mail me these lists by June 7th. We will discuss this at our next meeting on June 17th. The importance of these lists will give us greater representation at the Eastern Region about concerns for the state of Indiana.

2. The second step is that we want to develop regional surveys work with other states on similar problems either via commodity or pathway. We realize that we will have to pick invasive pests from the lists provided; however, with greater funding to the CAPS program it is our intention develop 1-page summaries that we can present to National about proposed surveys with other states. Realizing that pest of Illinois, Kentucky, Ohio, Michigan, etc. are of concern to the state of Indiana. By submitting our regional survey work, we hope to be able to look at invasive pests that affect Indiana as well as our neighboring states. Proposed ideas are: soybeans as a commodity with Illinois and Iowa, nurseries as a pathway, and solid wood packing as a pathway. Steve Yaninek was able to meet with our counterparts at Illinois and they are interested in working with us on soybeans as commodity.

Additional CAPS Committee Members:

I would like to suggest the addition of the following 2 individuals to the CAPS Committee.

1. **Ellen Jacquart** is the Director of Stewardship of the Indiana Chapter of the Nature Conservancy. The majority of her work revolves around invasive plant species control and prescribed fire. She is also the co-chair of the Invasive Plant Species Assessment Working Group in Indiana. I believe her work with invasive plant species fills a void and will be a valuable asset the CAPS Committee.

2. **Jodie Ellis** is the Exotic Invasive Outreach Coordinator at Purdue University. She is heavily involved with the educational outreach for exotic invasive insect pests. I believe her education outreach activities will enhance the outreach activities of the CAPS program and that she will be a valuable asset the CAPS Committee.

Important Dates:

June 7th, 2004: Have your corresponding lists submitted via e-mail to me regarding invasive species in Indiana.

June 17th, 2004: CAPS Meeting in Room 104, Smith Hall from 1:00-4:00 pm to finalize FY 2005 budget.

Minutes for Indiana CAPS Committee Meeting (06-17-04)

Purpose:
The purpose of this meeting is to discuss and develop a list of exotic invasive pests of concern to the State of Indiana to be sent to the Eastern Region CAPS Committee for the FY 2006 Eastern Region CAPS Invasive Pest List. We also discussed the addition of Area-wide surveys, Area-wide Survey of Invasive Pests in Soybeans and Exotic Wood Borer Outreach Prototype for the Midwest Region, for consideration for the FY 2005 Budget.

The objectives to the Area-wide Survey of Invasive Pests in Soybeans is to 1) establish a regional surveillance program in soybean fields of Illinois, Indiana, and Iowa; 2) the survey will focus on a major agricultural production system for this region; and 3) the survey will provide long-term sentinel sites to monitor temporal and spatial changes in the plant health of the heart of the soybean belt. This regional area-wide survey approach will allow current CAPS targets, e.g. *M. vitrata,* to be monitored as well as other targeted exotic invasive pests of regional concern over an extended period of time. With well over 27 million acres of soybean produced each year in Illinois, Iowa, and Indiana at risk, it would be important for agriculture to know if this pest is present in the state. *Maruca vitrata* is a serious pest on several legume crops grown in the US and we would predict that this insect would survive in the southern US on these hosts. It is considered one of the most destructive pests of beans in Hawaii and is a major pest of cowpeas in most of Africa. Surveys conducted will also include the monitoring for other potential exotic invasive pests including Soybean Aphid, Soybean Rust, and Kudzu, as well as providing background information regarding currents pests of soybean. The data collected in this manner will allow for changes in pest composition in time and space to be evaluated on a regional basis.

The benefit of this regional area-wide survey is that it would provide a surveillance net cast over the heart of the soybean belt. This project will provide information about the presence or absence of damaging exotic invasive pests not known to occur in Illinois, Iowa, and Indiana or the United States. Knowledge of the existence of these exotic invasive pests would be crucial to agriculture as Illinois, Iowa, and Indiana produce over 27 million acres of soybean per year.

Introductions of exotic wood boring pests on solid wood packing material into Indiana pose a significant threat to forest and urban forest resources. Despite vigilant CAPS survey efforts, first detections of significant wood boring pests such as emerald ash borer, *Agrilus planipennis*, Asian Longhorned beetle, *Anoplophora glabripennis,* pine shoot beetle, *Tomicus piniperda,* and the European wood wasp, *Sirex noctilio,* did not come from CAPS projects. Our objective is to promote awareness of this problem among pest control operators who already work with importers and are more likely to detect these pests. Assistance from CAPS would be used to develop printed materials and an educational video production for distribution in businesses that are at risk as ‘ground zero’ for exotic species introductions, and for the salary of an hourly student assistant to aid in implementation of the program.

This program will increase interceptions of exotic wood boring insects in solid wood packing material. Urban pest control operators, trained in the identification of common insect pests, are often employed by importers to fumigate containers that contain insects. Often, it is their inspections that alert the importers about the presence of pests. Increased training of these personnel about the importance of detecting and reporting exotic pests will increase the probability that these interceptions will be properly identified and reported.

Attendance:
Jim Pheasant, CAPS
Karen Rane, BTNY
Gary Simon, APHIS-PPQ
Steve Yaninek, ENTM
Gail Ruhl, BTNY
Jim Carroll, USDA-APHIS
Christopher Pierce, CAPS

Exotic Invasive Pests of Concern to the State of Indiana

This list of exotic invasive pests was developed by the Indiana CAPS Committee to be considered by the Eastern Region CAPS Committee for the FY 2006 Eastern Region CAPS Invasive Pest List. These exotic invasive pests are of major concern to Indiana's agricultural and natural resources.

Insects

Asian ambrosia beetle, *Xylosandrus crassiusculus* (Mot.)
Asian longhorn beetle, *Anoplophora glabripennis*
Bamboo longhorn beetle, *Chlorophorus annularis*
Banded elm bark beetle, *Scolytus schevyrewi*
Bark beetle, *Hylurgops palliatus*
Black spotted longhorn beetle, *Anoplophora malasiaca*
Black spruce beetle, *Tetropium castaneum*
Brown spruce longhorn beetle, *Tetropium fuscum*
Emerald ash borer, *Agrilus planipennis*
European gypsy moth, *Lymantria dispar*
European spruce bark beetle, *Ips typographus*
Exotic bark beetles complex (Scolytidae)
Exotic wireworms, *Agriotes* spp.
Gallmaking maple borer, *Xylotrechus spp.*
Goldenhaired bark beetle, *Hylurgus ligniperda*
Hemlock woolly adelgid, *Adelges tsugae* Annand
Japanese cedar longhorn beetle, *Callidiellum rufipenne*
Japanese pine sawyer beetle, *Monochamus alternatus*
Longhorn beetle, *Xylotrechus spp.*
Longhorned wood borer, *Hesperophanes campestris*
Old world bollworm, *Helicoverpa armigera* (Hübner)
Pine bark beetle, *Pityogenes chalcographus*
Pine shoot beetle, *Tomicus piniperda*
Soybean aphid, *Aphis glycines*
Soybean pod borer, *Etiella zinckenella* Tr.
Variant western corn rootworm, *Diabrotica virgifera virgifera* LeConte
Viburnum leaf beetle, *Pyrrhalta viburni* (Paykull)
Wood wasp, *Sirex noctilio*
Xylotrechus undulatus borer, *Xylotrechus spp.*

Pathogens

Bacterial leaf scorch, *Xylella fastidiosa*
Beech bark disease, *Nectria coccinea* var. *faginata*
Black stem rust, *Puccinia graminis* f. sp. *tritici*
Butternut canker, *Sirococcus clavigignenti-juglandacearum*
Chrysanthemum white rust, *Puccinia horiana* Henn.
Fusarium wilt of watermelon, *Fusarium oxysporum* f. sp. *niveum*
Oak wilt, *Ceratocystis fagacearum*
Soybean rust, *Phakopsora pachyrhizi*
Sudden oak death, *Phytophthora ramorum*
Wheat streak mosaic (WSM)

Weeds

Autumn olive, *Eleaganus umbellata* Thunb.
Buckthorn(s), *Rhamnus* spp.
Bush honeysuckle(s), *Lonicera* spp.
Eurasian watermilfoil, *Myriophyllum spicatum* L.
Garlic mustard, *Alliaria petiolata* [Bieb]
Giant hogweed, *Heracleum mantegazzianum*
Herbicide resistant weeds (Round-up)
Japanese honeysuckle, *Lonicera japonica* Thunb.
Kudzu, *Pueraria montana* (Lour.)
Purple loosestrife, *Lythrum salicaria* L.
Russian-Olive, *Elaeagnus angustifolia* L.

Invertebrates

Giant African land snail, *Achatina fulica*

Minutes for Indiana CAPS Steering Committee Meeting (09-22-04)

Attendance: Dr. Christopher Pierce, Indiana State CAPS State Survey Coordinator
Dr. Steve Yaninek, Head of the Entomology Department, Purdue University
Dr. Robert Waltz, State Plant Regulatory Official
Gary Simon, USDA APHIS PPQ

Agenda

1. Amendments to the FY 2004 CAPS Budget (Due date October 15)
    a. Graduate Student Funding - $3,000.00
    b. Travel Expenses - $1,000.00

2. FY 2005 SOD Survey
    a. Not on FY 2005 Survey Plans/ National Survey?

3. PI for CAPS Program

4. Eastern Region CAPS Committee
    a. Contacted Dick Bean; awaiting response
    b. Plan to resubmit

FY 2004 Indiana Cooperative Agricultural Pest Survey (CAPS) Annual Accomplishment Report

NAPIS Data Submissions: Indiana Plant Board Report for FY 2004

Target Pest	Counties	Sites* Plants	Traps	Positives	Negatives
SUDDEN OAK DEATH MATING TYPE 2 VISUAL PHYTOPHTHORA RAMORUM NATIONAL NURSERY SUDDEN OAK DEATH SURVEY	20	1016		0	1016
SUDDEN OAK DEATH MATING TYPE 2 VISUAL PHYTOPHTHORA RAMORUM SOD FOREST ENVIRONS SURVEY	12	102		0	102
GERANIUM BACTERIAL WILT GEN. PEST OBSER. RALSTONIA (P.) SOLANACEARUM R3 B2 GENERAL PEST OBSERVATION; LAB CONFIRMED	7	200		0	200
KARNAL BUNT ELEVATOR;SPEC SITE TILLETIA (NEOVOSSIA) INDICA NATIONAL KARNAL BUNT SURVEY;OPTICAL SCAN	19	19		0	19
GIANT AFRICAN SNAIL (GAS) GEN. PEST OBSER. ACHATINA FULICA GENERAL PEST OBSERVATION; LAB CONFIRMED	2	90		90	0
GIANT AFRICAN SNAIL (GAS) ERADICATION ACHATINA FULICA DECLARATION OF PEST ERADICATION	2	4		0	4
EUROPEAN RED MITE CONSENSUS PANONYCHUS ULMI SCIENTIFIC CONSENSUS/GENERAL AGREEMENT	92	92		92	0
CUBAN LAUREL THRIPS VISUAL GYNAIKOTHRIPS FICORUM GENERAL NURSERY INSPECTION	5	5		5	0
EMERALD ASH BORER GEN. PEST OBSER. AGRILUS PLANIPENNIS GENERAL PEST OBSERVATION; LAB CONFIRMED	1	3		3	0
EMERALD ASH BORER TRAPPING AGRILUS PLANIPENNIS NATIONAL EXOTIC WOODBORER/BARK BEETLE	26	148		0	148

FY 2004 Indiana Cooperative Agricultural Pest Survey (CAPS) Annual Accomplishment Report

Target Pest	Counties	Sites* Plants	Traps	Positives	Negatives
EMERALD ASH BORER VISUAL AGRILUS PLANIPENNIS EMERALD ASH BORER SURVEY	1	19		19	0
ASIAN CERAMBYCID (LH.) BEETLE TRAPPING ANOPLOPHORA GLABRIPENNIS (LONGHORNED) NATIONAL EXOTIC WOODBORER/BARK BEETLE	26	1108		0	1108
JAPANESE CEDAR LONGHORN BEETLE TRAPPING CALLIDIELLUM (PALAEOCALLIDIUM) RUFIPENNE NATIONAL EXOTIC WOODBORER/BARK BEETLE	26	148		0	148
LONGHORNED BEETLE; A TRAPPING ANOPLOPHORA MALASIACA NATIONAL EXOTIC WOODBORER/BARK BEETLE	26	148		0	148
LONGHORNED BEETLE; A TRAPPING HESPEROPHANES (TRICHOFERUS) CAMPESTRIS NATIONAL EXOTIC WOODBORER/BARK BEETLE	26	148		0	148
SAWYER BEETLE; A TRAPPING MONOCHAMUS ALTERNATUS NATIONAL EXOTIC WOODBORER/BARK BEETLE	26	148		0	148
BROWN SPRUCE LONGHORNED BEETLE TRAPPING TETROPIUM FUSCUM NATIONAL EXOTIC WOODBORER/BARK BEETLE	26	148		0	148
LONGHORNED BEETLE; A TRAPPING TETROPIUM CASTANEUM NATIONAL EXOTIC WOODBORER/BARK BEETLE	26	148		0	148
CERAMBYCID BEETLE; A TRAPPING XYLOTRECHUS SPP. NATIONAL EXOTIC WOODBORER/BARK BEETLE	26	148		0	148
CEREAL LEAF BEETLE (CLB) CONSENSUS OULEMA MELANOPUS SCIENTIFIC CONSENSUS/GENERAL AGREEMENT	92	92		92	0

FY 2004 Indiana Cooperative Agricultural Pest Survey (CAPS) Annual Accomplishment Report

Target Pest	Counties	Sites* Plants	Traps	Positives	Negatives
JAPANESE BEETLE (JB) CONSENSUS POPILLIA JAPONICA SCIENTIFIC CONSENSUS/GENERAL AGREEMENT	92	92		92	0
SMALLER EUR. ELM BARK BEETLE CONSENSUS SCOLYTUS MULTISTRIATUS SCIENTIFIC CONSENSUS/GENERAL AGREEMENT	92	92		92	0
PINE SHOOT BEETLE (PSB) TRAP TOMICUS PINIPERDA TRAP;LINDGREN	10		81	6	75
PINE SHOOT BEETLE (PSB) CONSENSUS TOMICUS PINIPERDA SCIENTIFIC CONSENSUS/GENERAL AGREEMENT	61	61		61	0
ASIAN AMBROSIA BEETLE; AN TRAPPING XYLOSANDRUS CRASSIUSCULUS NATIONAL EXOTIC WOODBORER/BARK BEETLE	5	23		23	0
SPRUCE BARK BEETLE TRAPPING IPS TYPOGRAPHUS NATIONAL EXOTIC WOODBORER/BARK BEETLE	26	148		0	148
EASTERN WHITE PINE BARK BEETLE TRAP PITYOGENES HOPKINSI TRAP;LINDGREN	1		3	3	0
SCOLYTID BEETLE; A TRAPPING XYLEBORUS SP. NATIONAL EXOTIC WOODBORER/BARK BEETLE	26	148		0	148
SIXTOOTHED BARK BEETLE TRAPPING IPS SEXDENTATUS NATIONAL EXOTIC WOODBORER/BARK BEETLE	26	148		0	148
REDHAIRED PINE BARK BEETLE TRAPPING HYLURGUS LIGNIPERDA NATIONAL EXOTIC WOODBORER/BARK BEETLE	26	148		0	148

FY 2004 Indiana Cooperative Agricultural Pest Survey (CAPS) Annual Accomplishment Report

Target Pest	Counties	Sites* Plants	Traps	Positives	Negatives
SIXTOOTHED SPRUCE BARK BEETLE TRAPPING PITYOGENES CHALCOGRAPHUS NATIONAL EXOTIC WOODBORER/BARK BEETLE	26	148		0	148
BARK BEETLE; A TRAPPING HYLURGOPS PALLIATUS NATIONAL EXOTIC WOODBORER/BARK BEETLE	26	148		0	148
LESSER PINE SHOOT BEETLE TRAPPING TOMICUS MINOR NATIONAL EXOTIC WOODBORER/BARK BEETLE	26	148		0	148
EXOTIC BARK BEETLE; AN TRAPPING TRYPODENDRON DOMESTICUM NATIONAL EXOTIC WOODBORER/BARK BEETLE	26	148		0	148
BARK BEETLE; A TRAPPING SCOLYTUS SCHEVYREWI NATIONAL EXOTIC WOODBORER/BARK BEETLE	1	1		1	0
HESSIAN FLY CONSENSUS MAYETIOLA DESTRUCTOR SCIENTIFIC CONSENSUS/GENERAL AGREEMENT	92	92		92	0
APPLE MAGGOT (AM) CONSENSUS RHAGOLETIS POMONELLA SCIENTIFIC CONSENSUS/GENERAL AGREEMENT	92	92		92	0
SPOTTED ALFALFA APHID CONSENSUS THERIOAPHIS MACULATUS SCIENTIFIC CONSENSUS/GENERAL AGREEMENT	92	92		92	0
SOYBEAN (SOYA BEAN) APHID CONSENSUS APHIS GLYCINES SCIENTIFIC CONSENSUS/GENERAL AGREEMENT	92	92		92	0
POTATO LEAFHOPPER CONSENSUS EMPOASCA FABAE SCIENTIFIC CONSENSUS/GENERAL AGREEMENT	92	92		92	0

FY 2004 Indiana Cooperative Agricultural Pest Survey (CAPS) Annual Accomplishment Report

Target Pest	Counties	Sites* Plants	Traps	Positives	Negatives
SAN JOSE SCALE (SJS) CONSENSUS QUADRASPIDIOTUS PERNICIOSUS SCIENTIFIC CONSENSUS/GENERAL AGREEMENT	92	92		92	0
PEAR PSYLLA CONSENSUS CACOPSYLLA PYRICOLA SCIENTIFIC CONSENSUS/GENERAL AGREEMENT	92	92		92	0
STEELBLUE WOODWASP [EUROPEAN] TRAP SIREX NOCTILIO TRAP; LOG/BOLE SURVEY;FOREST PESTS	1		40	0	40
GYPSY MOTH (EUROPEAN)(GM) TRAP LYMANTRIA DISPAR TRAP;MILK CARTON PHEROMONE (GYP MOTH)	13		2199	624	1575
GYPSY MOTH (EUROPEAN)(GM) TRAP LYMANTRIA DISPAR TRAP;DELTA PHEROMONE	91		15633	371	15262
GYPSY MOTH (EUROPEAN)(GM) CONSENSUS LYMANTRIA DISPAR SCIENTIFIC CONSENSUS/GENERAL AGREEMENT	7	7		7	0
ASIAN GYPSY MOTH (AGM) TRAP LYMANTRIA DISPAR SSP. TRAP;MILK CARTON PHEROMONE (GYP MOTH)	1		15	0	15
BOLLWORM;CORN EARWORM;(BW-CEW) CONSENSUS HELICOVERPA ZEA (TOMATO FRUITWORM;PODW) SCIENTIFIC CONSENSUS/GENERAL AGREEMENT	92	92		92	0
FALL ARMYWORM (FAW) CONSENSUS SPODOPTERA FRUGIPERDA SCIENTIFIC CONSENSUS/GENERAL AGREEMENT	92	92		92	0
OLD WORLD BOLLWORM TRAP HELICOVERPA ARMIGERA TRAP;HELIOTHIS LURE	6		18	0	18

FY 2004 Indiana Cooperative Agricultural Pest Survey (CAPS) Annual Accomplishment Report

Target Pest	Counties	Sites* Plants	Traps	Positives	Negatives
EUROPEAN CORN BORER (ECB) CONSENSUS OSTRINIA NUBILALIS SCIENTIFIC CONSENSUS/GENERAL AGREEMENT	92	92		92	0
LILAC (ASH) BORER (LLB) GEN. PEST OBSER. PODESIA SYRINGAE GENERAL PEST OBSERVATION; LAB CONFIRMED	1	1		1	0
EUROPEAN PINE SHOOT MOTH(EPSM) CONSENSUS RHYACIONIA BOULIANA SCIENTIFIC CONSENSUS/GENERAL AGREEMENT	92	92		92	0
SOYBEAN CYST NEMATODE (SCN) CONSENSUS HETERODERA GLYCINES SCIENTIFIC CONSENSUS/GENERAL AGREEMENT	81	81		81	0
PROFESSOR-WEED (GOATSRUE) VISUAL GALEGA OFFICINALIS WEED SURVEY GENERAL; INF. AREA	84	84		0	84
KUDZU AERIAL PUERARIA LOBATA AERIAL SURVEY	24	56		56	0
GIANT HOGWEED GEN. PEST OBSER. HERACLEUM MANTEGAZZIANUM GENERAL PEST OBSERVATION; LAB CONFIRMED	1	1		1	0
GIANT HOGWEED VISUAL HERACLEUM MANTEGAZZIANUM WEED SURVEY GENERAL; INF. AREA	84	84		0	84

FY 2004 Indiana Cooperative Agricultural Pest Survey (CAPS) Annual Accomplishment Report

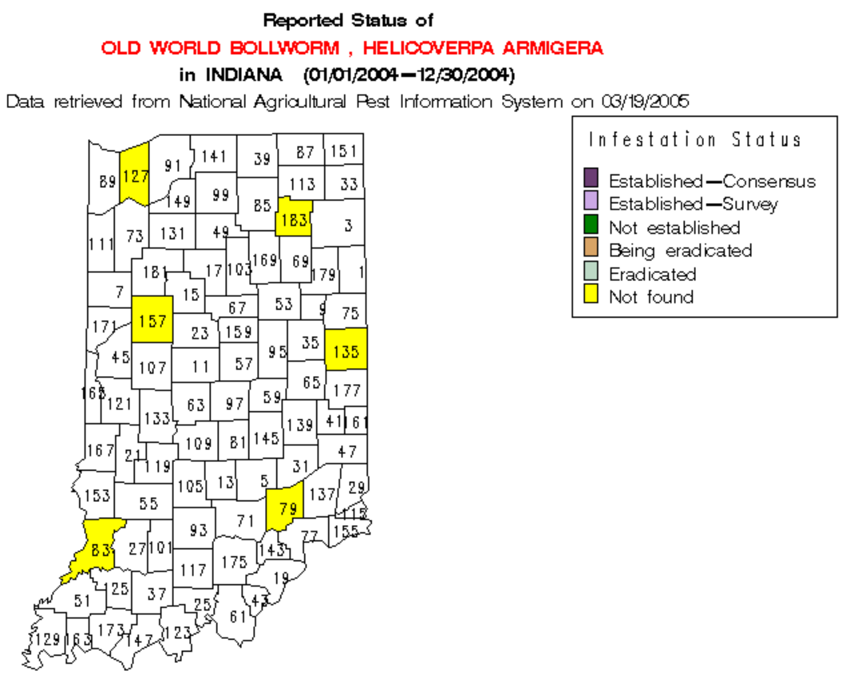
Indiana CAPS Survey Activity FY 2004:

Name of Project: Old World Bollworm Trapping **Fiscal Year:** 2004

Project Coordinator: Dr. Christopher Pierce **State:** Indiana

Objective:
Old World Bollworm, *Helicoverpa armigera,* larvae feed on several crops important to Indiana agriculture such as corn, soybeans, and alfalfa. About 5.9 million acres of corn, 5.8 million acres of soybeans, and 625 thousand acres of alfalfa are grown in Indiana each season. The objective was to determine if *H. armigera* is present in the state of Indiana; and to some degree, what extent it may be present.

A. Surveying Methodology (Materials and Methods):
Funnel traps (3 traps per site) for *H. armigera* were placed in 6 Indiana Counties (Porter, Whitley, Tippecanoe, Randolph, Knox, and Jennings) in late June. Funnel traps using rubber impregnated with pheromones are serviced on a bi-weekly schedule and will continue to be serviced until the end of October. Suspect specimens were to be sent to a designated USDA taxonomist.



B. Rationale Underlying Survey Methodology:
Surveying methodology protocol was followed from the Pest Risk Assessment (PRA) for *H. armigera*. The six sites (2 in southern, 2 in central, and 2 in northern Indiana) chosen in Indiana are our sentinel plots for *H. armigera* survey work. The placement of these sites provided us a comprehensive base for us to evaluate if *H. armigera* was present in the state of Indiana.

C. Survey Dates:
Pheromone traps (3 traps per site) for *H. armigera* were placed in 6 Indiana Counties (Porter, Whitley, Tippecanoe, Randolph, Knox, and Jennings) in late June. Funnel were serviced on a bi-weekly schedule and continued to be serviced until the end of October.

D. Taxonomic Services:
Dr. Christopher Pierce examined specimens. Dr. Christian Oseto served as taxonomic support for this project. Suspect specimens were to be sent to a designated USDA taxonomist. A morphological study of *H. assulta*, *H. punctigera*, and *Heliothis virescens* (formerly *H. rubrescens*) compares similarities and differences between species; a key was provided for identifying adults (Kirkpatrick 1961a) in the *H. armigera* PRA.

E. Benefits and Results of Survey:
This project provided information about the presence or absence of a damaging insect not known to occur in Indiana or the United States. Knowledge of the existence of this pest species is crucial to Indiana agriculture as the state grows nearly 12 million acres of corn and soybeans (two hosts of *H. armigera*). *Helicoverpa armigera* were not present in any of the traps during the 2004 survey season.

All survey data from each survey were entered into the NAPIS database. First records for the State and/or County were entered **within 48** hours of confirmation of identification by a qualified identifier. All other required records, both positive and negative, were entered **within two weeks** of confirmation. All records were entered into the NAPIS database by **December 1** of the year of the survey, so these data are included in the yearly Plant Board Report.

FY 2004 Indiana Cooperative Agricultural Pest Survey (CAPS) Annual Accomplishment Report

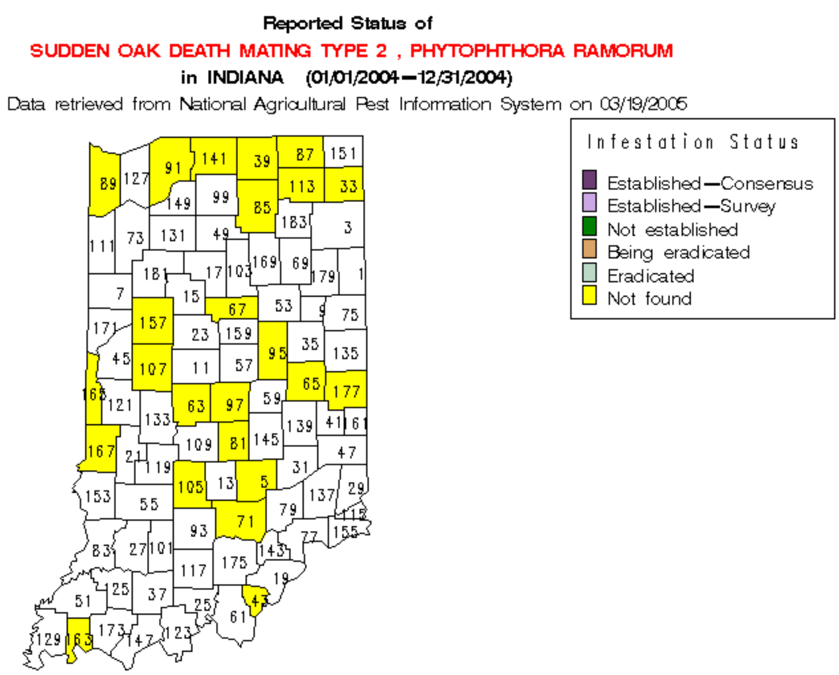
Name of Project: Sudden Oak Death disease survey **Fiscal Year:** 2005

Project Coordinator: Gail Ruhl and Dr. Robert Waltz **State:** Indiana

Objective: In March of 2004, a shipment of 1.6 million plants from a large nursery in California to nurseries and garden centers throughout the United States, including Indiana, inadvertently contained plants infected with *Phytophthora ramorum*. Many of the plants were sold prior to nursery investigation by state and federal inspectors. Phytophthora ramorum, initially 'confined' on the west coast has now been confirmed in 21 states. The objective of this preliminary survey was to detect the presence of *Phytophthora ramorum*, the causal agent of Sudden Oak Death, in Indiana nurseries that received shipment of nursery stock from geographical areas of California and Oregon which are known to harbor the pathogen.

A. Surveying Methodology (Materials and Methods):

In March 2004, when it was discovered that plants had been shipped from a California SOD-infected nursery to other U.S. states, paperwork was initiated to trace those shipments. The United States Department of Agriculture (USDA)-Animal and Plant Health Inspection Service (APHIS) and IDNR inspectors inspected all recipient nurseries. No suspect plants were found in Indiana nurseries, however, to ensure the absence of SOD in Indiana nursery stock, the Purdue Plant and Pest Diagnostic Laboratory (P&PDL) partnered with the IDNR to participate in a National SOD survey funded by USDA/APHIS to scout for the presence of *P. ramorum* in nursery stock. In Indiana, 870 symptomatic samples were collected by IDNR inspectors and submitted to the P&PDL for testing. Sixty two of those samples tested positive for a *Phytophthora* species in a preliminary analysis (the test is not specific for *P. ramorum*). Those samples were sent to the USDA-APHIS Plant Pest Quarantine (PPQ) Laboratory in Beltsville, Md., for conclusive speciation testing. All those tests were negative.



B. Rationale Underlying Survey Methodology:

In March 2004, when it was discovered that plants had been shipped from a California SOD-infected nursery to other U.S. states, paperwork was initiated to trace those shipments. The United States Department of Agriculture (USDA)-Animal and Plant Health Inspection Service (APHIS) and IDNR inspectors inspected all recipient nurseries. No suspect plants were found in Indiana nurseries, however, to ensure the absence of SOD in Indiana nursery stock, the Purdue Plant and Pest Diagnostic Laboratory (P&PDL) partnered with the IDNR to participate in a National SOD survey funded by USDA/APHIS to scout for the presence of *P. ramorum* in nursery stock.

C. <u>Survey Dates</u>:
The SOD survey was conducted in the months of March and April 2004.

D. <u>Taxonomic Services</u>:
No suspect plants were found in Indiana nurseries, however, to ensure the absence of SOD in Indiana nursery stock, the Purdue Plant and Pest Diagnostic Laboratory (P&PDL) partnered with the IDNR to participate in a National SOD survey funded by USDA/APHIS to scout for the presence of *P. ramorum* in nursery stock. In Indiana, 870 symptomatic samples were collected by IDNR inspectors and submitted to the P&PDL for testing. Sixty two of those samples tested positive for a *Phytophthora* species in a preliminary analysis (the test is not specific for *P. ramorum*). Those samples were sent to the USDA-APHIS Plant Pest Quarantine (PPQ) Laboratory in Beltsville, Md., for conclusive speciation testing.

E. <u>Benefits and Results of Survey</u>:
Millions of dollars have been lost by California and Oregon nurseries found to be infected with *P. ramorum.* The negative results of our nursery survey for *P. ramorum* contribute to safe trade and sales for the 3.4 billion dollar retail lawn and garden industry in Indiana.

In addition, plant disease diagnosticians for the P&PDL have chosen to participate in the national "*Phytophthora ramorum* Educate to Detect" (PRED) program. They have assembled an Indiana SOD task force comprised of University and IDNR Specialists who will assist with training. A variety of SOD training opportunities will be provided to associations and groups including arborists, nurserymen, landscapers, nursery inspectors, county extension educators and Master Gardeners this winter and next spring.

Indiana has 1.8 million acres of oak and hickory type trees and ranks 6th in the nation for retail lawn and garden sales. Undetected infections of *P. ramorum* on nursery and garden center plants, could significantly impact the $3.4 billion retail lawn and garden industry not to mention the oaks in the Hoosier National Forest. IDNR inspectors inspect over 600 Indiana nurseries bi-annually for the presence of diseases and insects. The Purdue P&PDL tested 870 samples submitted by inspectors for SOD testing. Sixty-two samples were forwarded to Beltsville, as per federal guidelines, for conclusive testing. No positive *P. ramorum* samples were found in Indiana nurseries. The P&PDL will continue to partner with the IDNR for SOD surveillance and training in 2005.

FY 2004 Indiana Cooperative Agricultural Pest Survey (CAPS) Annual Accomplishment Report

Name of Project: Wood boring and bark beetle warehouse survey **Fiscal Year:** 2005

Project Coordinator: Dr. Christopher Pierce **State:** Indiana

Objective:
A joint survey between USDA APHIS PPQ and the Indiana CAPS program selected 50 warehouses in Indiana that have a high risk for the introduction of exotic invasive wood boring and bark beetles. The Indiana CAPS program was responsible for 6 survey sites in central and northeastern Indiana. The following high risk sites have been identified in Indiana (see "Hot Zone Sites").

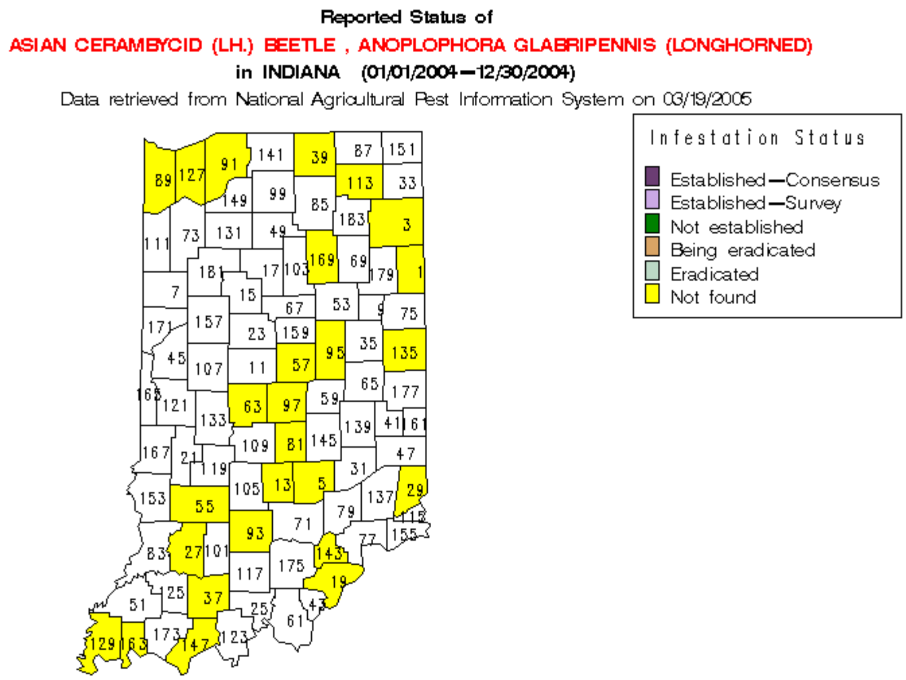
- "Hot Zone" – sites that have received known infested materials – 1st priority.
- "Secondary Shipping Zone Area" – sites that receive material from known infested suppliers – 2nd priority.
- "Tertiary Areas" – sites that have a high potential for introduction, but no confirmed infested material received (i.e., pallet recyclers, sea container storage yard) – 3rd priority.

Pests (include survey targets described in Part I, or Core, category):
Citrus longhorn beetle, *Anoplophora chinensis*
Asian longhorn beetle, *Anoplophora glabripennis*
Black spotted longhorn beetle, *Anoplophora malasiaca*
Japanese cedar longhorn beetle, *Callidiellum rufipenne*
Bamboo longhorn beetle, *Chlorophorus annularis*
Longhorned wood borer, *Hesperophanes campestris*
Goldenhaired bark beetle, *Hylurgus ligniperda*
Japanese pine sawyer beetle, *Monochamus alternatus*
Brown spruce Longhorn beetle, *Tetropium fuscum*
Pine bark beetle, *Pityogenes chalcographus*
Black spruce beetle, *Tetropium castaneum*
Longhorn beetle, *Xylotrechus spp.*
Bark beetle, *Hylurgops palliatus*
Xylotrechus undulatus borer, *Xylotrechus spp.*
Banded elm bark beetle, *Scolytus schevyrewi*
Gallmaking maple borer, *Xylotrechus spp.*
European spruce bark beetle, *Ips typographus*

A. <u>Surveying Methodology (Materials and Methods)</u>:
A joint survey between USDA APHIS PPQ and the Indiana CAPS program selected 50 warehouses in Indiana that have a high risk for the introduction of exotic invasive wood boring and bark beetles. Three Lindgren funnel traps were placed and serviced at each of the 7 selected sites. Each trap was baited with one of the three lures or lure combinations:

- Ultra-high release (UHR) ethanol lure (black pouch) only (general attractants for woodboring insects in deciduous hosts).
- UHR alpha-pinene (blue pouch) and UHR ethanol (black pouch) lures together (general attractants for woodboring insects in coniferous hosts).
- Three-component exotic bark beetle lure (2 bubble caps, one pouch). More specific for conifer-feeding exotic bark beetles e.g. *Ips typographus*, *Ips sexdentatus, Hylurgus ligniperda* and *Orthotomicus erosus*.

Traps were placed in mid-March and serviced bi-weekly until the end of October.



B. Rationale Underlying Survey Methodology:
Survey methodology followed the protocol in the “National Exotic Woodborer/ Bark Beetle Survey Pan 2003/2004”.

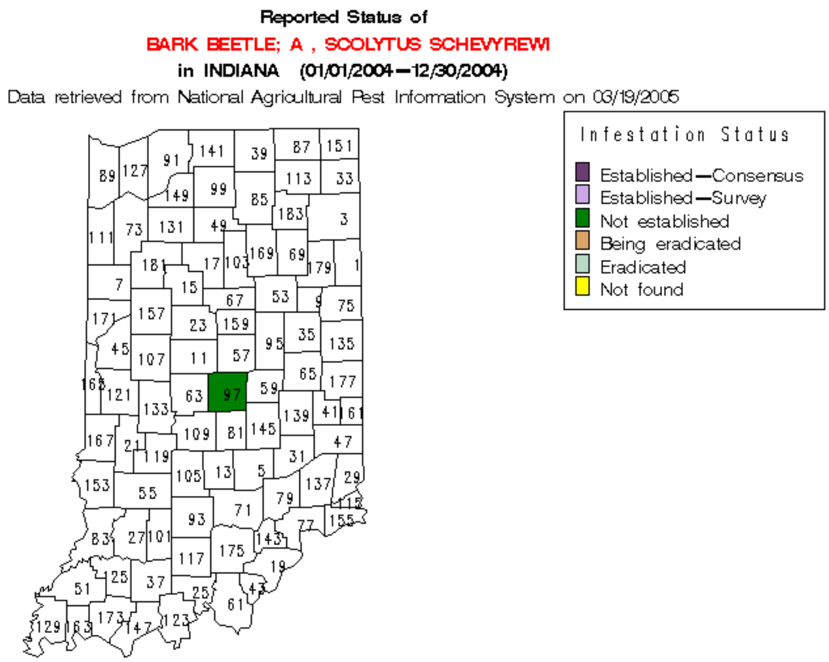
C. Survey Dates:
The trapping period was throughout the approximate adult activity period from mid-March through the end of October, 2004.

D. Taxonomic Services:
Dr. Christopher Pierce examined specimens collected throughout the sampling period. Bark beetle and longhorn beetle specimens were also identified by Dr. Cliff Sadof, Dr. Jeffrey Holland, Arwin Provonsha, and Dr. Robert Waltz. Suspect specimens were to be sent to a designated USDA taxonomist.

E. Benefits and Results of Survey:
A joint survey between USDA APHIS PPQ and the Indiana CAPS program selected 50 warehouses in Indiana that have a high risk for the introduction of exotic invasive wood boring and bark beetles.

All survey data from each survey were entered into the NAPIS database. First records for the State and/or County were entered **within 48** hours of confirmation of identification by a qualified identifier. All other required records, both positive and negative, were entered **within two weeks** of confirmation. All records were entered into the NAPIS database by **December 1** of the year of the survey, so these data are included in the yearly Plant Board Report.

No pests targeted in the SWPM survey were collected except for banded elm bark beetles, *Scolytus schevyrewi* Semenov. It was collected in Marion County through this survey. No regulatory action was taken for this pest. The banded elm bark beetle affects elms and autumn olive - among other plants.



Additional State Survey Programs:

A. European Gypsy Moth program:

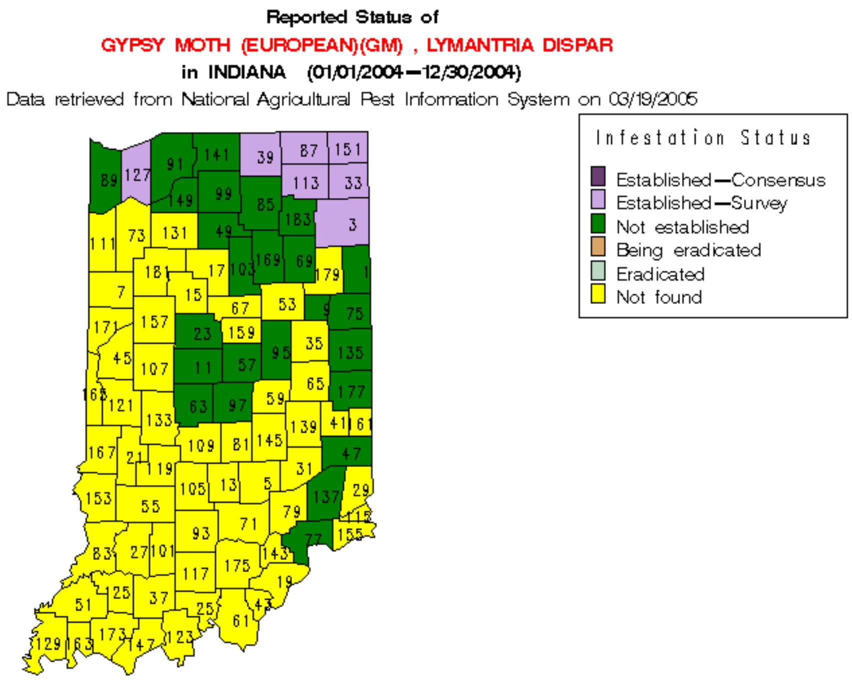
The 2004 Cooperative Gypsy Moth Survey completed its 17th year of the statewide survey. The survey is part of the Slow-The-Spread (STS) Program and uses the STS protocol for its' design and operation dividing the state into three zones – the STS Evaluation Zone, the STS Action Zone, and the State Area. The survey design uses fixed 3K, fixed 2K, and rotating 3K, respectively, for the tree zones. Across all zones, the survey set 13,385 detection and 4,030 intensive traps all referenced by GPS. The survey detected 9,014 moths from 32 counties ranging from 1 to 2,520 moths per county. This is a decrease from 2002 and 2003 (15,569 and 23,090 respectively), but did not return to the low moth catch of 2000 (5,881).

The results of the 2004 survey found that the majority of the moth catch came in the Action Zone. The Evaluation Zone, which includes the quarantined counties of Steuben, LaGrange, Elkhart, Noble, Allen, and DeKalb, detected 43.1% of the moths (3,997 of 9,014). The northern third of the state falls in the Action Zone, which is below the Evaluation Zone under STS protocol. The Action Zone detected 56.7% of the moths (5,108 of 9,014). The majority of the moth catch in this zone is located in the eastern part of the state directly under the Evaluation Zone. This year's high percent of moth capture in the Action Zone compared to 2003 (36.5%) is in part due to a large increase in the number of delimiting traps; approximately 1000 more traps than in the previous year. The State Area detected 19 moths, primarily single moth detection traps. The State Area had two 3 count traps in two separate locations. All positive traps in the state zone are delimited the following year.

Treatments to eradicate and slow-the-spread and –development of gypsy moth were conducted on 39 sites in 13 counties. Twenty-two sites totaling 3,969 acres were treated with Btk at 30 BIU/acre/application. Thirteen sites were treated with two applications (2,362 acres). Nine sites were inside mating disruption sites and treated with one application (1,607 acres). Eight sites totaling 8,298 acres and nine sites totaling 30,579 acres in eleven counties received one application of pheromone flakes for mating disruption at 6 and 15 grams, respectively, in June. Delimit surveys to monitor treatment success found two Btk blocks failed (Arcola & Cobb's Corners). This was most likely due to small block sizes and bad weather.

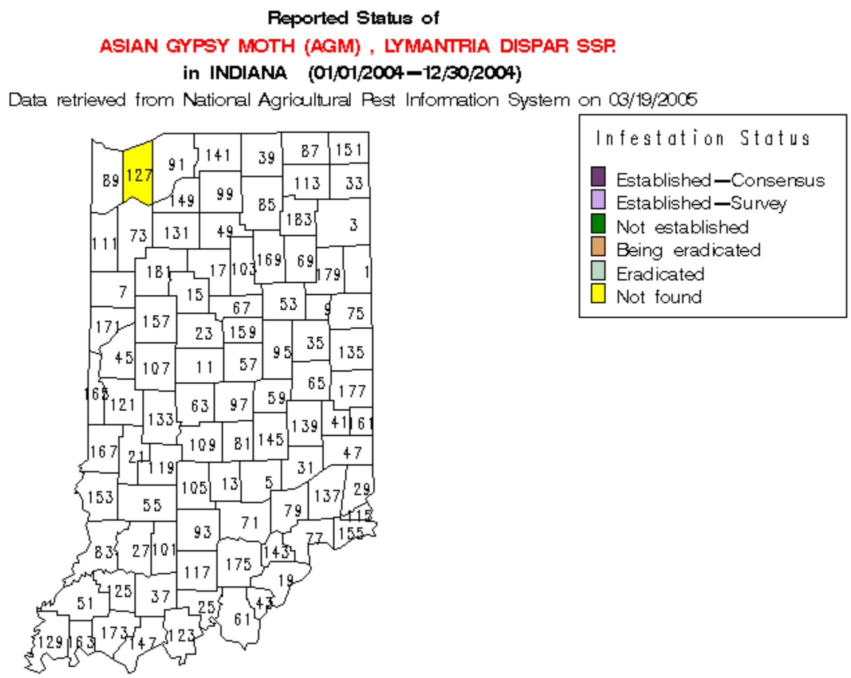
The aerial survey of the five northeastern counties in the Evaluation Zone and the other counties with treatment sites in the Action Zone did not detect defoliation. No defoliation was seen a Parkview Hospital in Fort Wayne, where, it was seen last year. This is due to the dramatic reduction in moth population. The hospital and surrounding areas were sprayed with Btk, which reduced the moth catch from 30,300 moths found in 130 traps in 2003 to 62 moths found in 15 traps this year. A treatment of Btk in 2005 has been purposed to "clean up" the site and to insure that management goals for the area are met.

The moth lines projected for 2004 have remained static across the state with no significant change from the moth lines for 2002 and 2003. The survey and program to manage gypsy moth in Indiana continues to compress the distance between the moth lines, thus slowing the spread of gypsy moth in Indiana. Since the survey began in 1972, 250,772 moths have been caught in 90 of the 92 counties. No new county records were set this year.


Reported Status of
GYPSY MOTH (EUROPEAN)(GM) , LYMANTRIA DISPAR
in INDIANA (01/01/2004–12/30/2004)
Data retrieved from National Agricultural Pest Information System on 03/19/2005
Infestation Status
Established–Consensus
Established–Survey
Not established
Being eradicated
Eradicated
Not found

B. <u>Asian Gypsy Moth survey</u>:

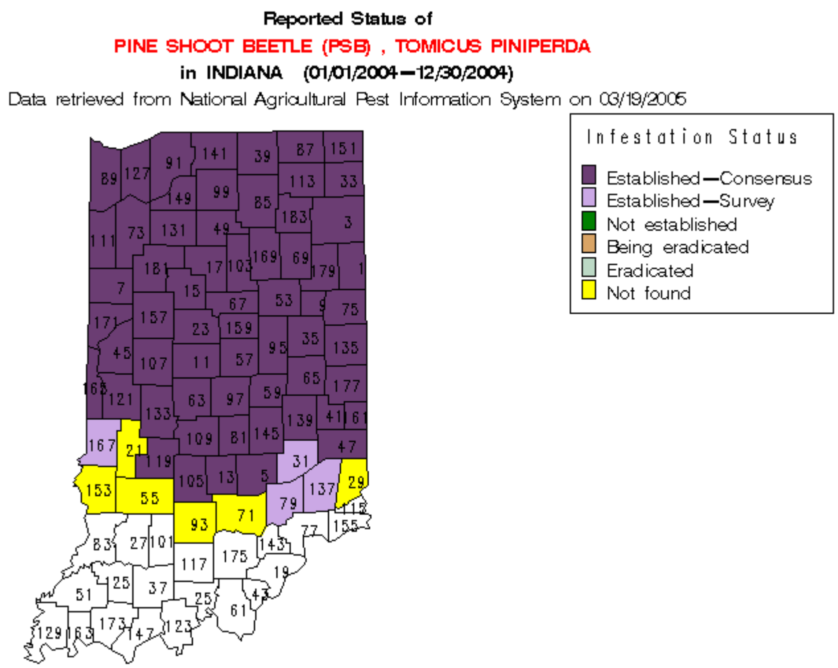
The Asian Gypsy Moth survey is conducted by USDA APHIS PPQ. The Asian Gypsy Moth was surveyed for Porter County this past year. The Asian Gypsy Moth survey resulted in no detection of this pest in 2004.



FY 2004 Indiana Cooperative Agricultural Pest Survey (CAPS) Annual Accomplishment Report

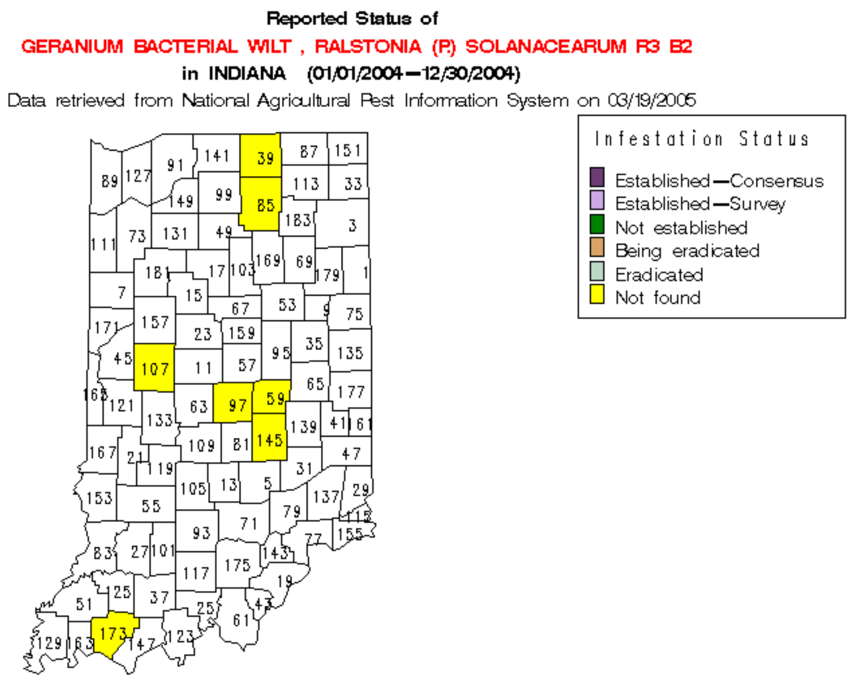
C. Pine shoot beetle survey:

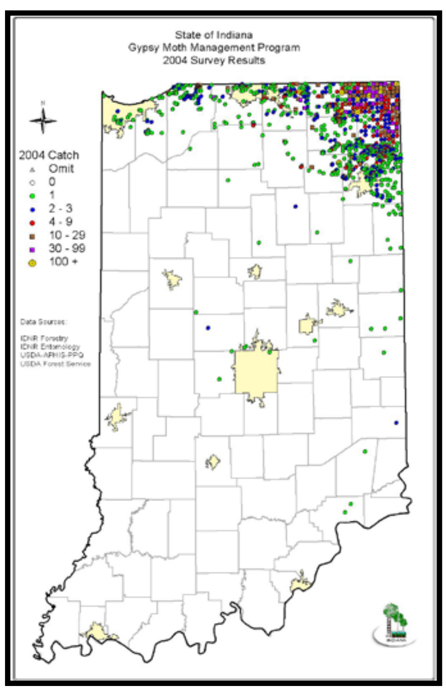
The Pine shoot beetle (PSB) survey is conducted by USDA APHIS PPQ. Indiana DNR handles the State quarantine compliance and monitors nurseries and production areas. A total of 80 PSB were set in 10 counties in Indiana in 2004 (8 per county) from January 20th thru June 30th, 2004. Counties surveyed in 2004 were: Clay, Dearborn, Decatur, Greene, Jackson, Jennings, Lawrence, Ripley, Sullivan, and Vigo. On April 23rd, 2004, pine shoot beetle was discovered in Vigo, Decatur, Jennings, and Ripley Counties in Indiana. As of June 7th, 2004, USDA APHIS amended the pine shoot beetle regulations by adding Vigo, Decatur, Jennings, and Ripley Counties in Indiana to the list of quarantined areas. This action is necessary to prevent the spread of pine shoot beetle, a pest of pine products, into non-infested areas of the United States.



D. *Ralstonia solanacearum* race 3 Biovar 2:

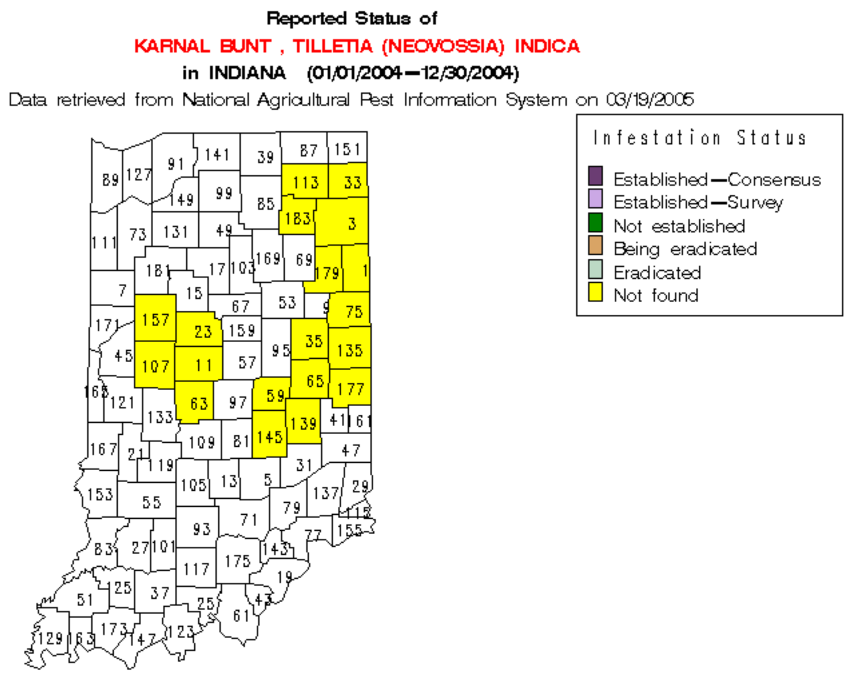
Ralstonia solanacearum survey is conducted by USDA APHIS PPQ. *Ralstonia solanacearum* race 3 biovar 2 was surveyed for in greenhouses this past year. Ralstonia is on the USDA's Agricultural Bioterrorism Act of 2002 Select Agents and Toxins list. It causes common wilt in geraniums and infects numerous solanaceous plants (e.g. tomatoes, and peppers and is a major concern to the potato industry. The ralstonia survey resulted in no detection of this pathogen in 2004.





E. <u>Karnal bunt of wheat survey</u>:

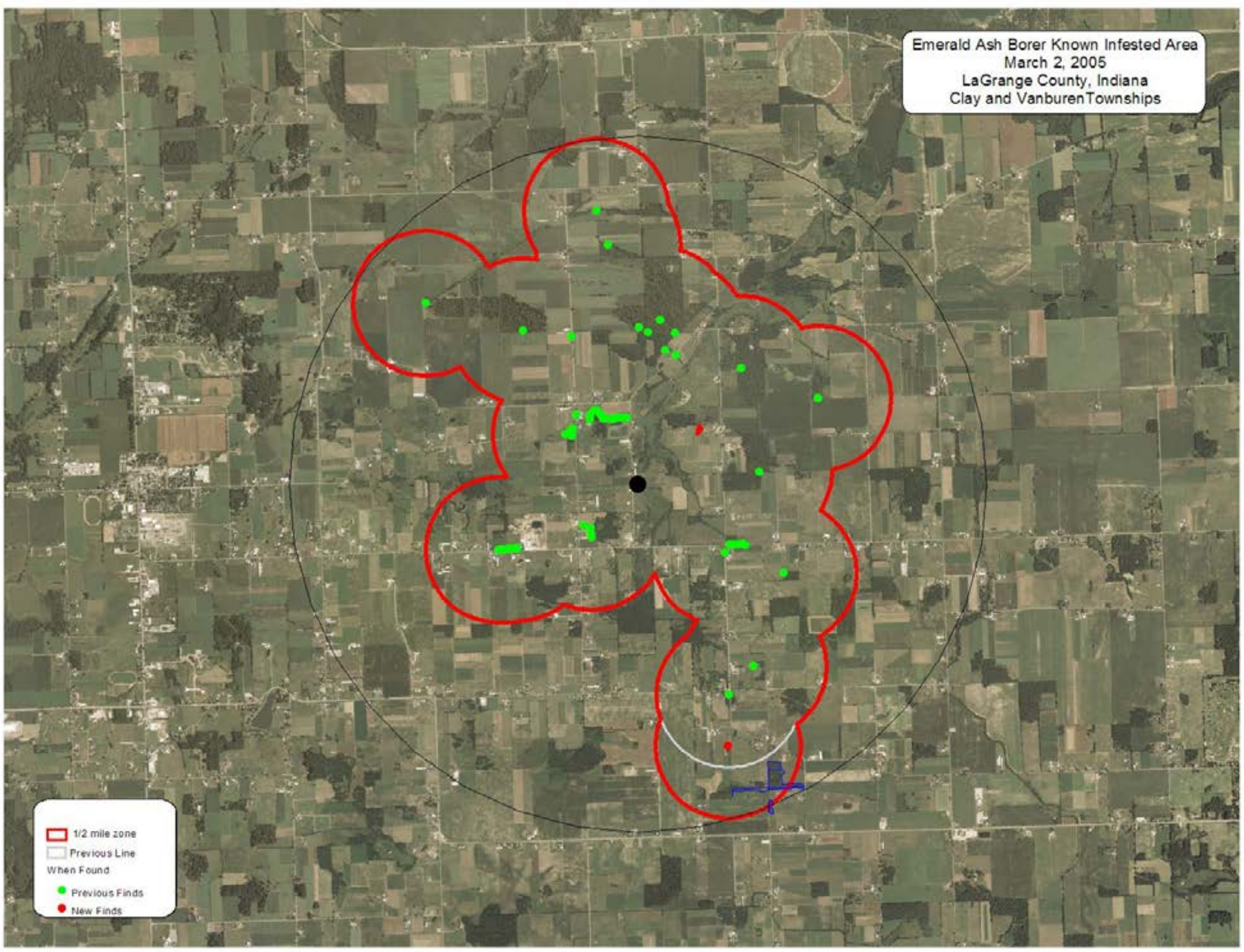
In 2004, the karnal bunt of wheat survey was conducted by USDA APHIS PPQ and was responsible for drawing and submitting samples according to USDA guidelines. Three samples collected resulted in negative findings of karnal bunt of wheat in Indiana. Samples represented grain from 15 different counties in Indiana which include: Adams, Boone, Clinton, Delaware, Hancock, Hendricks, Henry, Jay, Montgomery, Randolph, Rush, Shelby, Tippecanoe, Wayne, and Wells.



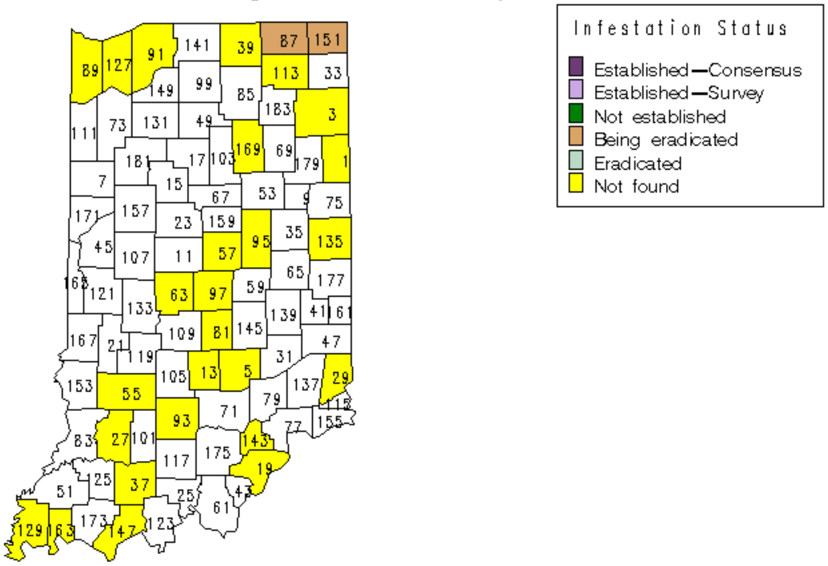
F. <u>Emerald ash borer survey</u>:

Emerald ash borer, *Agrilus planipennis* (Fairmaire), was the most problematic invasive insect during 2004. Two counties, LaGrange and Steuben County, have townships under quarantine due to this pest. On April 19, IDNR and USDA APHIS placed Jellystone Campground, Fremont (Steuben County: Jamestown Township) under quarantine. On May 26, IDNR and USDA APHIS placed Shipshewana, (Lagrange County: Clay Township) under quarantine. On August 22, IDNR and USDA APHIS placed (Lagrange County: Van Buren Township) under quarantine. In the spring 2004, Winchester (Randolph County) received nursery stock containing a partial dead adult. It was ruled as a regulatory interception and surveys were initiated for detection of emerald ash borer. On November 17, IDNR and USDA APHIS placed Manapogo Campground (Steuben County: Millgrove Township) under quarantine.

Emerald ash borer has been introduced into Indiana by three different forms of introduction. In Steuben County, emerald ash borer was introduced into Indiana from firewood from Michigan. In Lagrange county, emerald ash borer was introduced from infested ash trees into a lumber mill. In Randolph county, emerald ash borer was introduced into Indiana from infested nursery stock. An estimated 40,000 ash trees will be removed by the spring of 2005. There are approximately 147 million ash trees in Indiana. Over 6% of all forest trees in Indiana are ash. Ash trees are typically concentrated in urban settings. IDNR, USDA APHIS, Purdue University, and USDA Forest Service have ongoing research and surveys for emerald ash borer that will continue in 2005.



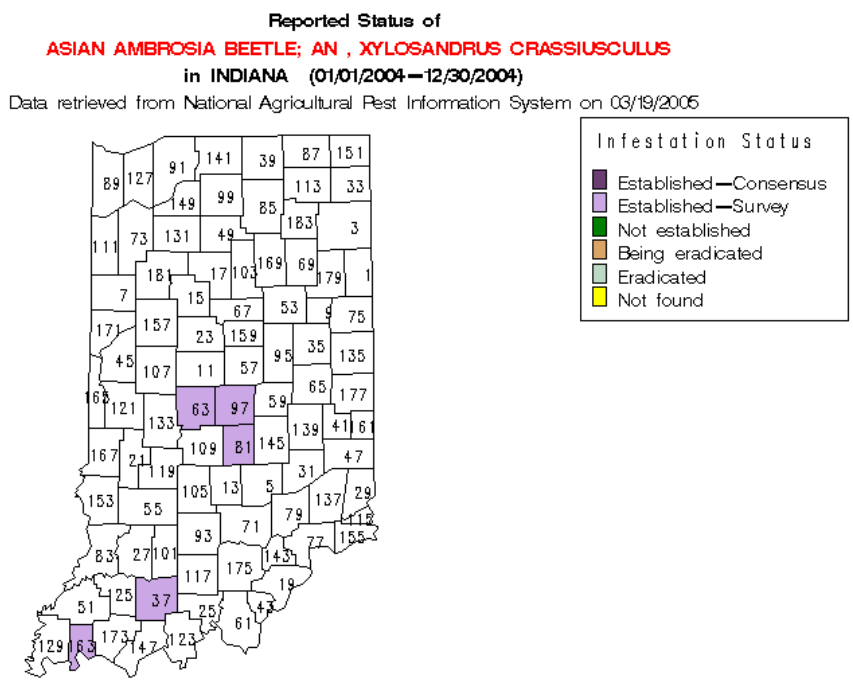
Reported Status of
EMERALD ASH BORER , AGRILUS PLANIPENNIS
in INDIANA (01/01/2004–12/30/2004)
Data retrieved from National Agricultural Pest Information System on 03/19/2005



G. <u>Asian Ambrosia Beetle</u>:

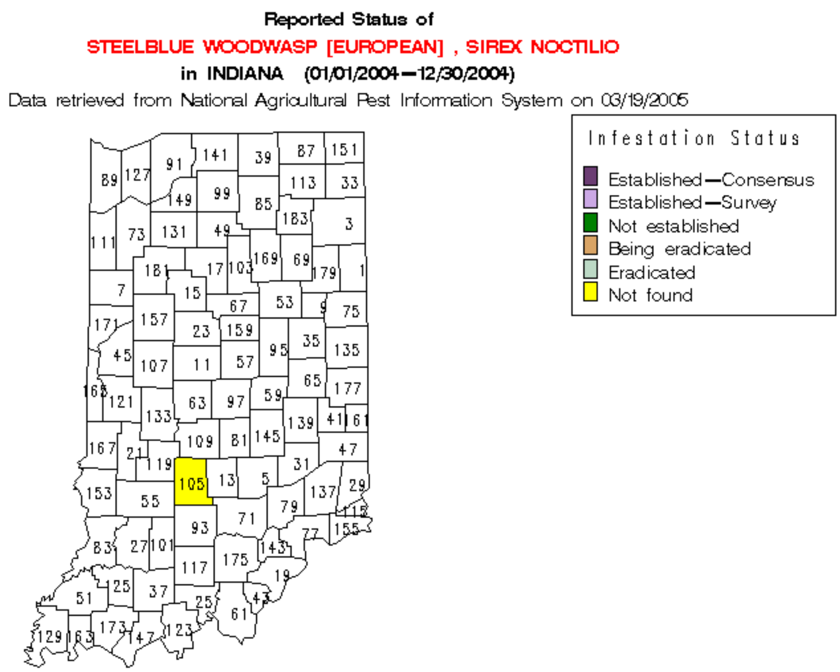
Asian ambrosia beetles, *Xylosandrus crassiusculus* (Mot.), were collected during Indiana Department of Natural Resources (IDNR) nursery inspections in Indiana in 2004. Asian ambrosia beetles are known to occur in Jackson and Bartholomew counties in Indiana; suspect specimens were collected in Boone, Hendricks, Johnson, and Monroe counties. No regulatory action has been taken for this pest. Host plants for the Asian ambrosia beetle include over 120 known plants for this pest; which includes: pecan, Chinese pistachio, red oak, bur oak, redbud, Bradford pear, and chinquapin oak. Females bore into plant trunks and inoculate the tunnel with fungal spores. The females then produce a brood. The larvae and the females feed on the fungus, not the host. Heavily infested plants usually die from the inoculated fungus or a secondary disease.

Asian ambrosia beetles, *Xylosandrus crassiusculus* (Mot.), were collected during Indiana Department of Natural Resources (IDNR) nursery inspections in Indiana in 2004. Asian ambrosia beetles are known to occur in Jackson and Bartholomew counties in Indiana; suspect specimens were collected in Boone, Hendricks, Johnson, and Monroe counties. No regulatory action has been taken for this pest. Host plants for the Asian ambrosia beetle include over 120 known plants for this pest; which includes: pecan, Chinese pistachio, red oak, bur oak, redbud, Bradford pear, and chinquapin oak. Females bore into plant trunks and inoculate the tunnel with fungal spores. The females then produce a brood. The larvae and the females feed on the fungus, not the host. Heavily infested plants usually die from the inoculated fungus or a secondary disease.



H. <u>European woodwasp survey</u>:

Surveys continued for the European woodwasp, *Sirex noctilio* Fabricius, in Bloomington, Indiana in 2004. *Sirex noctilio* was found in 2002 inside a factory warehouse in Bloomington, Indiana. Surveys for *S. noctilio* are in third year in Bloomington, Indiana. No positive specimens have been collected to date. *Sirex noctilio* infests all major commercial pine species. The female wasp drills into the wood and inserts a toxic mucous and the fungus, *Amylostereum areolatum,* into the tree. The mucous prevents the tree to defend itself against the fungus. The fungus grows and causes the tree to dry out (weeks to months). The combination of fungus and mucous kills the tree.



I. <u>Exotic Invasive Insects of Regulatory Concern in Indiana Stores</u>:

The United States Department of Agriculture (USDA) Animal and Plant Inspection Service (APHIS) issued a national recall on pinecones originating in India. These pinecones were sold both singly and in potpourri as a specialty holiday item. The recall was issued because two different insect pests have been intercepted: the slender banded pinecone longhorned beetle, *Chlorophorus strobilicola* Champion, a wood-boring beetle native to India, and larvae of a seed-feeding moth belonging to the genus Cydia. Both pests are not known to exist in the United States. On December 18, 2003, 21 UPC codes were listed in the recall; however, the number of recalled UPC codes continued to expand as state and federal inspectors located additional products. Pinecones infested with live insects were found in at least 11 states, including Indiana, New Jersey, New York, Maryland, and Delaware. Stores named for the recall were Jo-Ann Fabrics, Lowe's, Dollar Tree, Safeway, Frank's Nursery and Kmart. APHIS will now require mandatory fumigation for all pinecones from India entering U.S. ports of entry. Products packaged in impermeable wrappers will be refused entry unless they are removed from the packaging to allow effective treatment. No beetles were found in Indiana; however, several moths were collected.

The United States Department of Agriculture (USDA) Animal and Plant Inspection Service (APHIS), Plant Protection and Quarantine (PPQ) officers found live insect larvae in a product known as "Rustic Twig Tower" imported from China by McCann Bros. of Bridgeport, CT for White Flower Farm. The initial find was made in Wisconsin by a concerned consumer who purchased this product. The insect was identified as Cerambycidae*: Lamiinae* sp., an exotic invasive longhorned beetle. In addition to this infestation, a consumer in Florida also reported finding insect larvae in the same product. This product contained numerous insect larvae that were identified as Cerambycidae*: Callidiellum sp.,* another exotic invasive longhorned beetle. USDA APHIS is very concerned about the introduction of these two insect pests into the United States. Cerambycidae*: Lamiinae* sp. is known to infest hardwood trees. Cerambycidae*: Callidiellum* sp. is known to infest softwood trees such as sequoia, bald cypress, and other similar species. IDNR Division of Entomology and Plant Pathology recovered 8 trellises from around the state of Indiana.

In December of 2004, a recall of artificial Christmas trees with real-bark trunks manufactured by Polytree Hong Kong Co. Ltd. The Christmas trees imported from China contained a quarantine significant pest, the brown fir longhorned beetle, *Callidiellum villosulum* (Fairmaire), found in shipments in Illinois and Michigan. The adult beetles were removed from the wooden portion of the artificial tree sold in a Michael's Craft store. The product was traced back to the Polytree Company in China. Polytree was also involved with a recall on similar artificial trees sold at Ace Hardware. Further investigation by USDA APHIS found that heat treatment certificates accompanying the two shipments indicate the treatment conducted did not meet U.S. entry requirements. If you have these trees and find a live insect, please freeze them in plastic bags and turn them over to the local Agricultural Cooperative Extension Service for identification. The recall notice instructs consumers to return these trees to the stores in which they were purchased.

J. Brazilian elodea:

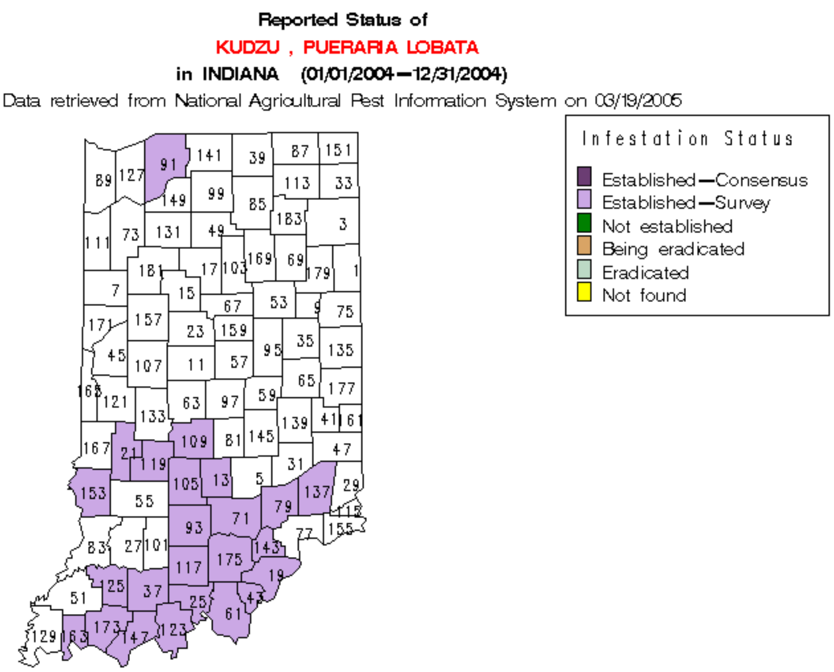
Brazilian elodea was found during an Indiana Department of Natural Resources plant survey of another invasive plant — the Eurasian water milfoil. This aquatic invasive plant was found in Bloomington's Griffy Lake and was treated by the Bloomington Water Company. Elodea, which forms in dense mats, threatens biological diversity by crowding out native plants and animals.

K. Yellow floating heart:

Yellow floating heart is a popular garden ornamental that appears to be an aggressive grower with the capability to establish in natural areas was found on 3 private properties this year. Fish and wildlife habitat, recreation and water quality is negatively impacted when the dense mats of yellow floating heart out competes native and beneficial plant species. It risks getting into major rivers such as Wabash River and Sugar Creek River

L. Kudzu:

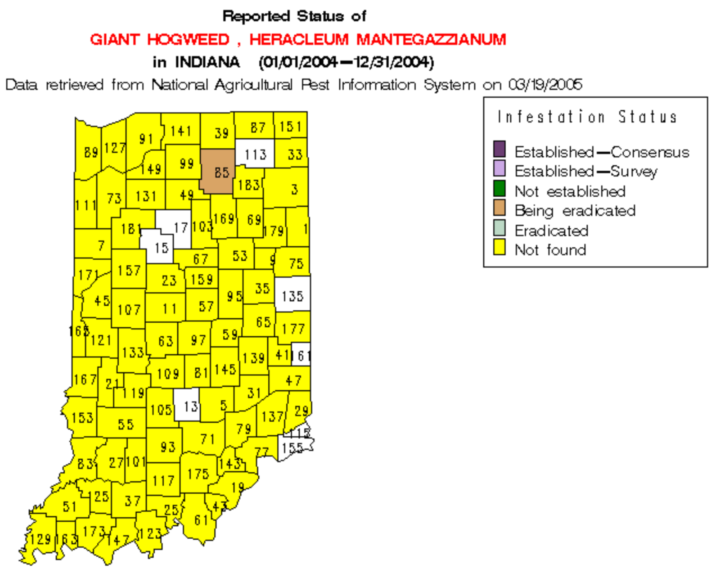
Indiana Department of Natural Resources also conducted a survey for kudzu. In Indiana there are 55 sites, in 24 counties, totaling 55 acres. Kudzu grows well under a wide range of conditions and in most soil types and is important due to its ability to act as an alternate host for soybean rust.

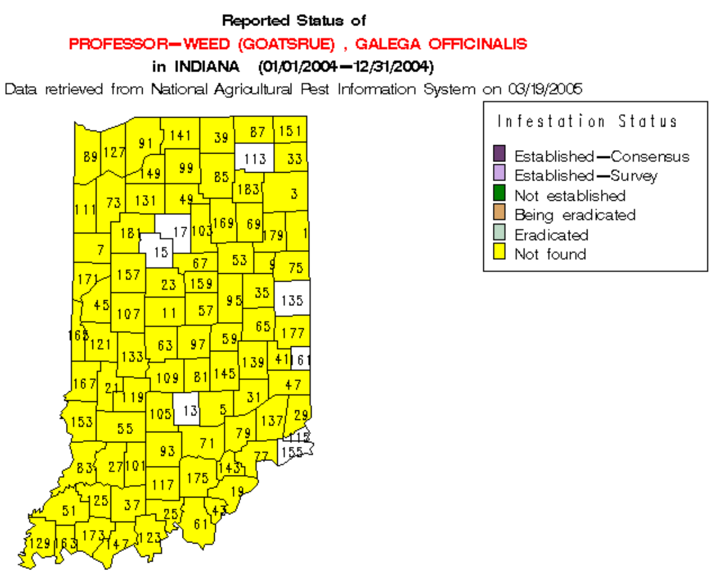


M. <u>Giant Hogweed and Goatsrue Survey</u>:

In Late June 2004, Indiana DNR - Div. of Nature Preserves surveyed for giant hogweed and goatsrue in Indiana. Indiana Department of Natural Resources – Division of Nature Preserves confirmed the first location for giant hogweed, *Heracleum mantegazzianum*, in Indiana. This invasive plant is a high priority for detection and control due both to its threat to human health and because we still have the chance to prevent it becoming established in the state.

The confirmed site was reported by a botanist from JF New at a site near Warsaw in NE Indiana. There were both first year seedlings and blooming plants at the site, so this is at least the second year it's been there. Indiana DNR - Div. of Nature Preserves believe the next nearest location for this species is NE Ohio, so this represents a pretty large leap for the plant and raises the possibility that it has managed to leap to other spots within the state or the Midwest. Goatsrue was not detected in surveys in Indiana in 2004.



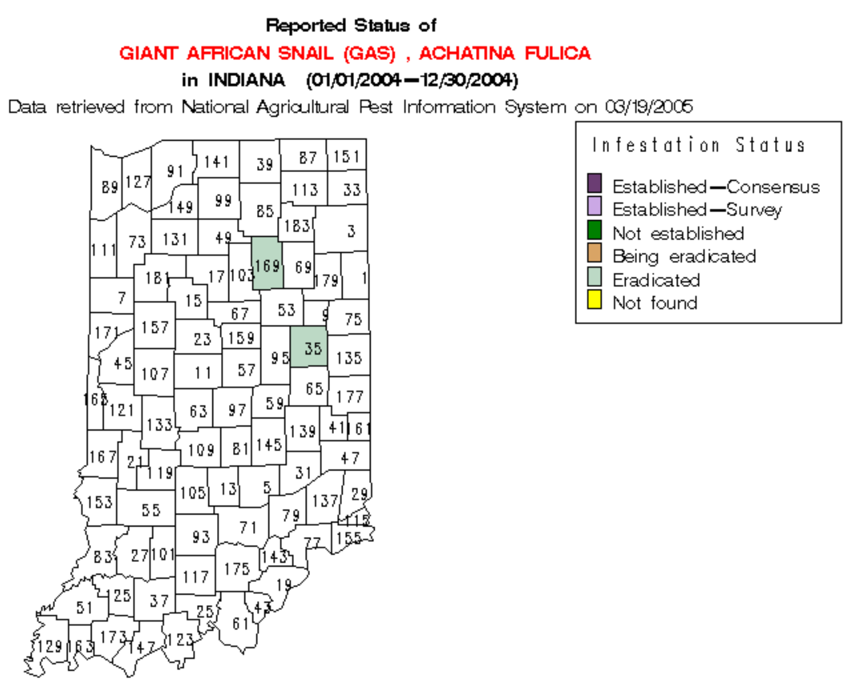


N. IPSAWG – Invasive Plant Species Assessment Working Group:

IPSAWG conducts surveys throughout the state for invasive weed species including exotic weeds by utilizing approximately 70 *bona fide* plant survey volunteers who are competent botanists. Report on assessment of autumn and Russian olive. On May 12th, 2004, Ellen Jacquart, Director of Stewardship Indiana Chapter of The Nature Conservancy, reported for the subcommittee that assessed autumn and Russian olive last month. There were several survey reports on autumn olive invading natural areas in Indiana, but none for Russian olive. It appears from all sources that Russian olive is not currently naturalizing in Indiana. The assessment of autumn olive resulted in an ecological impact score of 12 (medium), potential for expansion score of 31 (high), difficulty of management score of 35 (high), and value score of 3 (low). While Russian olive is not currently naturalized in Indiana, we used the potential for expansion portion of the assessment as a predictor and came out with a score of 31 (high). It was recommended that neither species be bought, sold, or planted in Indiana.

O. Giant African Land Snails:

On April 30th, 2004, the state announced a quarantine of the snails that said, in part, no person in Indiana may "possess, offer for sale, sell, give away, barter, exchange, or otherwise distribute or release a giant African land snail, in any life stage." Giant African land snails had been confiscated by a Wabash County health department worker earlier in the week. A federal quarantine has been in place for a number of years. The giant African land snail is considered to be the most threatening to the environment of any land snail in the world. This creature is known to eat hundreds of different types of plants including some grown as crops in Indiana. State health officials warn that individuals can become ill if they ingest snails that have not been completely cooked. The snails can carry the rat lung worm, which can cause individuals who eat raw or undercooked snails to develop meningitis and to suffer from permanent neurological damage. Although rat lung worm has not been reported in Indiana, state health officials are concerned it could have been imported from tropical areas. Scientists believe the giant African land snail is originally from East Africa. It is now commonly found throughout the Indo-Pacific Basin, including the Hawaiian Islands.



Addendum (Graduate Student Work):

Joanie Corn, a graduate student in the Department of Entomology, was supported by CAPS funds to conduct her MS research on invasive species. During her tenure at Purdue University, Ms Corn's personal situation changed. She married, had a baby, and withdrew from the university.

Another student, Rosanne Radavich was selected to continue Ms Corn's research project. Anne Radavich's plan of study was to use Palisade's simulation model to determine the risks associated with potential insect invaders. The corn pest complex in Indiana was to be used to test the parameters of the model. After her appointment to this project, Ms Radavich switched her project to a more education-based research. She is being supported through a teaching assistantship provided by the department.

Programs of study by Joanie Corn and Anne Radavich are attached information in Addendum.

Respectfully submitted,

Dr. Christopher M. F. Pierce, Indiana CAPS State Coordinator
March 18, 2005

Joanie Corn

I. Introduction
    a. An invasive species is a species that is alien to the ecosystem in consideration, and whose introduction causes, or is probable to cause, economic or environmental damage or harm to human health (Executive Order 13112, 1999).
    b. Increasing commerce, travel, and transportation of commodities is facilitating the chance of both deliberate and inadvertent movement of species (McNeely, et. al. 2001).
    c. Prevention is the preferred line of attack
II. Statement of Need
    a. Current situation (What's been done so far?)
    b. What needs to be done/mastered (Where do we want to go from here?)
    c. Previous solutions and strategies
    d. Proposed solutions and strategies
III. Summary
    a. Find common attributes of the top five intercepted pests of each of the last five years.
    b. Determine pathway analysis of these pests
        i. What is it about these pests?
        ii. Is there a common thread as to how they're getting in
    c. Compare and contrast with ESA exotic pest list
    d. Why are there discrepancies (unexpected problems)?
        i. What went wrong?
        ii. What could have been done?
IV. Project Description
    a. Compare and contrast 'intercept list' (top five intercepted pests of each of the last five years) with the ESA exotic pest list
    b. Which pests are unexpected problems? What fell through the cracks?
    c. Literature review on pests' biology
        i. Pathway analysis
        ii. Speed of dispersal
        iii. Distribution, commodities
        iv. Where and what they attack---host range
        v. Survey methods
        vi. Control measures in homeland
        vii. Pest in origin or incidentally?
        viii. Similar species
V. Conclusion
    a. Common attributes of these invasive species
    b. Proposed solutions, methods of prevention/control
    c. Ideas about where things have gone wrong/what was lacking to prevent invasions

Congressional Research Service, The Library of Congress. 1999. Harmful Non-Native Species: Issues for Congress. Order Code RL30123. 50 pp.

National Invasive Species Council. 2001. Meeting the Invasive Species Challenge: National Invasive Species Management Plan. 80pp.

McNeely, J.A., H.A. Mooney, L.E. Neville, P. Schei, and J.K. Waage (eds.) 2001. *A Global Strategy on Invasive Alien Species*. IUCN Gland, Switzerland, and Cambridge, UK, in collaboration with the Global Invasive Species Programme. X + 50pp.

Joanie Corn
10/19/2003

Introduction to the Proposal
Of the Invasive Species Project

The objective of this project is to find common attributes of the top five intercepted pests of the United States of each of the last five years. Also, there will be a pathway analysis for each of these pests. The question we are contending with is "What is it about these pests that permit them, specifically, to become problematic invaders?" Is it a biological attribute or a common pathway characteristic? This list of intercepted pests will be compared and contrasted with the ESA Exotic Pest list and there will subsequently be an investigation into possible causes of discrepancies between these lists.

Invasive species are everywhere; damaging crops, industry, the environment, and public health. They have heavy economic tolls and environmental costs. An invasive species is a species that is foreign to the ecosystem in concern, and whose introduction causes, or is likely to bring about, economic or environmental damage or detriment to human health (National Invasive Species Council, 2001; Executive Order 13112, 1999). Thus, "invasives" are alien species that not only take hold in their new (non-native) environment, but also become destructive or insidious (Mooney and Hobbs, 2000). Invasion of these non-indigenous creatures into new habitats can significantly alter ecosystem structure and function, and therefore have damaging effects of the indigenous biota in this new region (Mack, 1997, Pattison, R, 1998). Charles S. Elton wrote in regards to the fact that nearly all insect immigrants were introduced by mistake, and often in spite of heavy screens and quarantine (Elton, 2000).

Prevention of introduction is the first and most important cost-effective strategy. Regrettably, this is too often learnt the hard way. For example, the zebra mussel, native to the Black, Aral, and Caspian Seas, was transported to the Great Lakes by the water of ballast tanks. It spread inside a decade to 20 states, including the mouth of the Mississippi at the Gulf of Mexico. In 1999 it was discovered in the Missouri River. This mussel encrusts everything solid in the water (rocks, boats' hulls, pilings, pipes, and even other mussels) (Baskin, 2002). Invasive species can alter entire ecosystems by disrupting food chains, preying on critical native species such as pollinators, increasing frequency of fires, or—as in the case of some plants—simply overshadowing and smothering native plants (GAO, 2002). A Hawaiian study done by Pattison, et. al. uncovered that the leaves of invasive species will assimilate more $CO2$ than native species. Furthermore, invasive species were found to have superior physiological plasticity to respond to changes in light levels than the native species. Results of this study suggested that invasive species in Hawaii also have higher growth rates than the native species (Pattison, et. al., 1998).

It may be worth mention, that there is nothing inherently evil about these species. They have simply managed to migrate to and flourish in new environments; often through the aid of mankind, be it deliberately or by accident. A species does not know if it is native or not. It simply does what all living creatures have always done---survive as best they can in whatever the circumstances. What has changed and made these species "wicked" or "sinister" is not the species itself, but merely its context (Driesche, 2000).

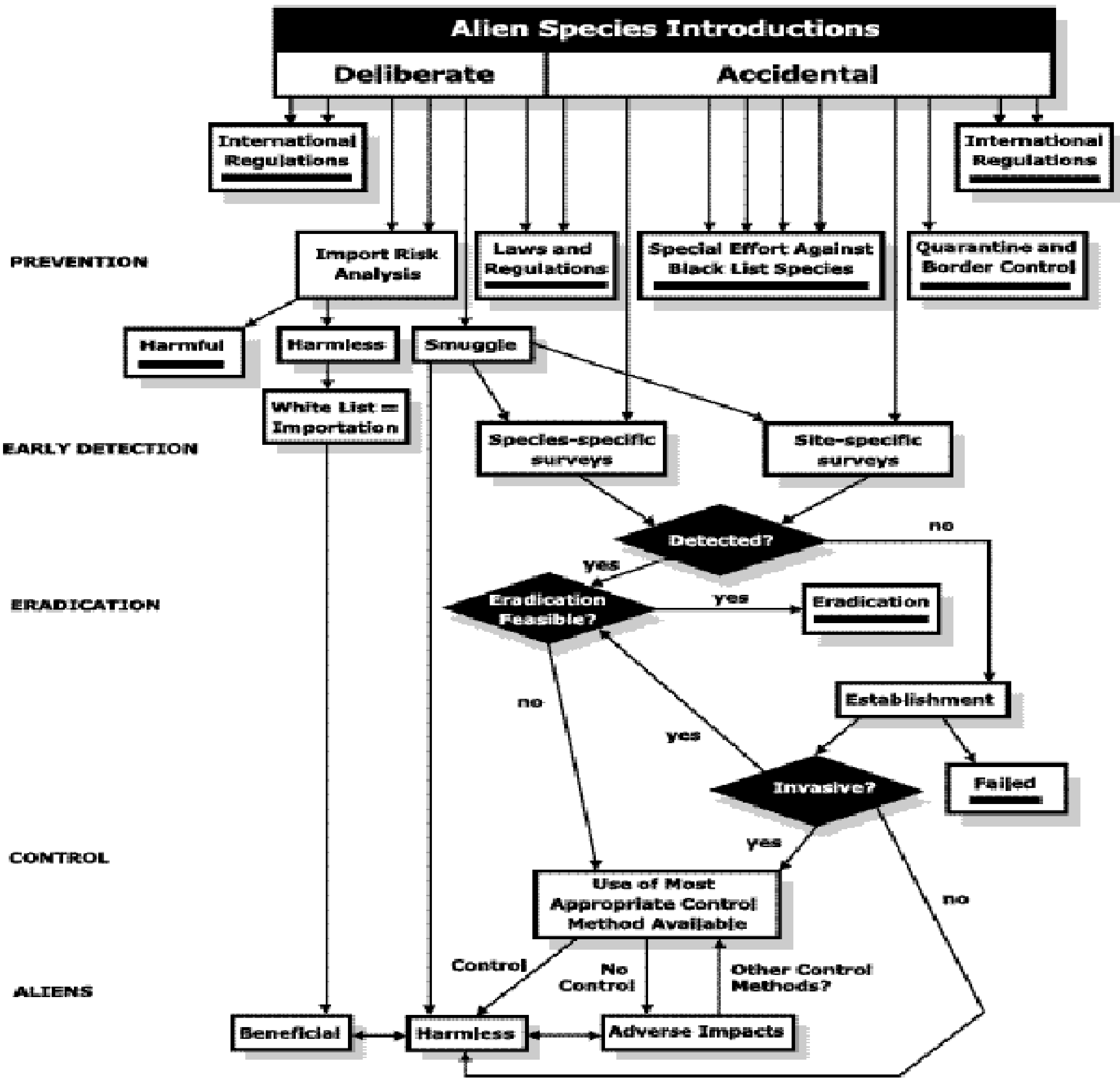


Figure 1 - Summary of options to consider when addressing alien species. Black bars mark the potential final stages of introduced alien species. Diamonds symbolise important bifurcations and decision points.

(GISPb, 2001)

Increasingly so, humans and materials can move practically without boundaries. This gives unwarranted authorization to the movement of many organisms, including destructive insects. This means that nearly all geographic locations are subject to recurrent invasion pressure (Yano, et. al., 1997). Invading species in the United States are accountable for major environmental damages and losses adding up to over $138 billion annually. There are about 50,000 of these foreign species (1999) and that number is on the rise. In fact, about 42% of the species on the Threatened or Endangered Species lists are at risk primarily because of invasive species (Pimentel, et. al., 1999).

Introduced insect species have and will continue to become pests of livestock, wildlife, and crop production. For example, face flies (*Musca autumnalis*), which are best identified by their tendency of swarming on the nostrils, muzzle, and eyes of cattle, were introduced with foreign livestock (Chirra, F and G.A. LaBarge, 1994; Drummond et. al., 1981). Another example is the red imported fire ant (*Solenopsis invicta*), which kills poultry, chicks, lizards, snakes, and ground nesting birds (Vinson, 1994). The gypsy moth (*Lymantria dispar*), intentionally introduced into Massachusetts in the 1800's for possible silk production, became a major pest of forest and ornamental trees in the United States, especially oaks (Campbell and Schlarbum, 1994). Introduced insects account for 98% of crop pest insects in Hawaii. In Florida 949 introduced species have, for the most part accidentally, invaded the state. However, forty-two of the introductions were intentional for the purpose of biological control (Frank and McCoy, 1995). Introduction of organisms for biological control, have on occasion caused damage to non-target species. Mostly this involved generalist predators (GISPb, 2001). In California 600 invasive species are responsible for 67% of all crop losses (Dowell and Krass, 1992). Each year, pest insects destroy about 13% of potential crop production representing $33 billion value in the United States. Moreover, nearly 40% of these pests are invasive species; estimating $13 billion costs caused by introduced pests each year (USBC, 1998; Pimentel, 1993 and 1997).

It is reported that over 50,000 species of plants, animals, and microbes have been introduced either accidentally or intentionally into the United States in the past hundred years. In the recent past the rates and risks associated with non-indigenous species have increased enormously. This is due to human population growth and human activities. Furthermore, about 360 invasive insect and mite species have become established within United States' forests. Insects cause the loss of approximately 9% of forest products, amounting to $7 billion annually. Since 30% of these pests are alien species, annual losses attributable to them are about $2.1 billion per year (Pimentel, 2002).

More and more attention is being aimed at the issue of biological invasions. There is now a substantial biotic homogenization of the Earth's surface as a consequence of the collapse of the major bio-geographical barriers that have in the past kept the vegetation and animal life of the different continents quite distinctive. This mixing has caused there to be numerous aggressive species with astonishingly wide dissemination, or having especially high local densities. This leads to the destruction of the native biota of specific areas. There is an entire series of processes that are changing, roused by human activities, all of which are probable to pick up the pace of the mixing of the Earth's biota and amplify the numbers of invasive species. These activities include land-use change, large-scale habitat modification (fragmentation of landscapes), clearing vegetation, and enhanced trade. Humans have both intentionally and unwittingly produced pathways for the unhindered movement of invasive species. It is obvious that not every species introduced to a new environment will cause problems. On the other hand, it is proven very difficult to predict in advance which species will be a problem (Mooney and Hobbs, 2000). A beginning point would be to look at species that are already invasive. Having an invasive species database that would be accessible worldwide would be a major advantage. This could be coupled with effective mechanisms for the prevention of transport and introduction of known and potential problem species. Also important would be an evaluation of relative risks and benefits of introducing species, particularly with commercially used species and their influence on forestry, horticulture, and aquarium trade. The probable benefits of introductions should be weighed against the possible economic and environmental costs. Furthermore, it should be made certain that those expected to benefit from an introduction would have to abide the costs related to any ensuing development of an invasion dilemma (GISPb, 2001).

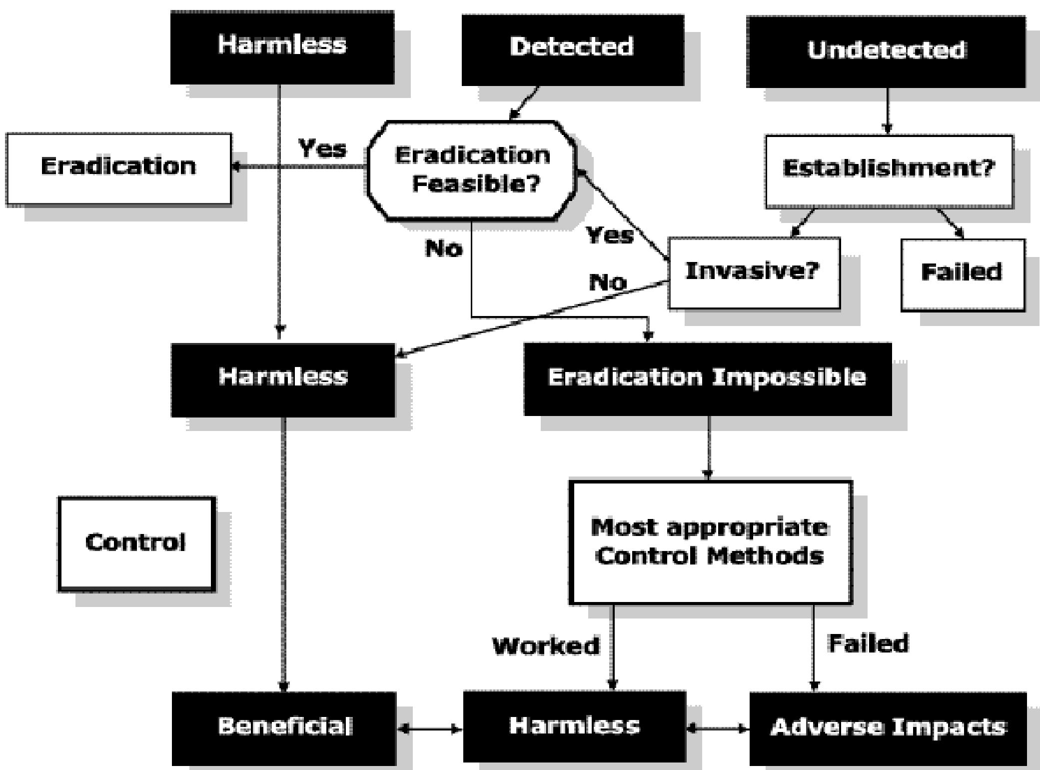


Figure 5.1 Eradication and control options after prevention has failed. After implementation of all proposed steps, the alien species will fit one of the three groups identified at the bottom of flowchart (see figure in the Toolkit Summary for the full flowchart).

(GISPB, 2001)

One of the most recently famous cases of invasive species, and the danger they can produce, is that of the Asian Long-Horned Beetle (*Anoplophora glabripennis*). It is believed to have arrived in the United States in the 1990's via solid wood-packing material from China. Unprocessed wood and wood products, such as packing materials, are an ideal breeding substrate for a vast number of invertebrates, including numerous beetles. Thus, the wood materials are a source of forest pests and pathogens. Strict regulations on importation and measures to decontaminate these materials are necessary. This invasion from China has created infestations in both Chicago and New York. The Asian Long-Horned Beetle has few natural enemies in China, and none yet known in North America. It prefers maple trees, including box elder, Norway, red, silver, sugar, and sycamore. This invasive pest has caused damage to the maple sugar production in the United States. The only way to eliminate this beetle is to remove and destroy infested trees by chipping and burning. In 1996 the State and Federal Government spent over $4 million on a suppression program in New York City and Amityville, NY (GISPb, 2001).

Photographs by Michael Bohne

Insects can be transported by a variety of means. For instance, Siberian timber imports have half of the world's supply of softwood timber. In the past, United States companies wanted to bring in raw logs from the area Russian Far East to West Coast USA sawmills in Siberia. These shipments are quite likely the pathway for invasive forest pests that are pre-adapted to many North American climate zones and tree communities. Devastating pathogens brought in through Siberian timber include chestnut blight (*Cryphonectria parasitica*), Dutch elm disease (*Ceratocysitis* ulmi), and white pine blister rust (*Cronartium ribicola*) (GISPb, 2001).

Shipping soil or soil attached to transported plants spreads soil pests. Soil pests that have spread in this manner include the sugarcane white grub (*Cemora smithi*), a beetle larva, which was transported from Barbados to Mauritius by means of soil attached to plants. An example of an insect that is transported by hiding in such cargo is the crazy ant (*Anoplolepis gracilipes*), which has spread throughout the tropics (CSIRO, 2002). The unusual features of this ant, such as its ability to form super-colonies with multiple queens, and having little territoriality, allow it to flourish in high densities and have population explosions. Strict quarantine procedures and inspections can help to thwart such stowaways. Treatment is available for suspect cargo. Packaging can be treated with pesticides: fumigation or immersion. Other types of management include heat, cold, and irradiation. Some treatments involve high labor and are expensive, but crucial. The increase in tourism and numbers of tourists and luggage means increased mobility and opportunity for "hitchhiker" insects. Such transport allows planes, passengers, and their luggage to become vectors for the introduction of alien species to remote areas (GISPa 2001; GISPb, 2001). In 1993 the Animal and Plant Health Inspection Service (APHIS) put the burden back on importers to advise new pest treatment options and procedures that would "evidence complete effectiveness" in mitigating risk of invasive species (U.S. Congress Office of Technology Assessment, 1993).

A national strategy on dealing with invasive species needs to be based on appraisal of the human dimensions of the problem and by analysis of the current situation. "All ecosystems worldwide are disturbed by human activities in one way or another" and this is the most driving force behind the introduction of alien species. Human behavior has led to most invasions and it undoubtedly follows that solutions will need to have such influence on human behavior. Exclusion methods based on pathways manage better than those focused on individual species, and are a more efficient way to focus efforts (GISPb, 2001).

It is easy to be pessimistic about the challenges of invasive species, but good science, adequate resources, and the proper tools can "win the day" (Mooney and Hobbs, 2000).

Bibliography

Campbell, F.T. and S.E. Schlarbaum. 1994. *Fading Forests: North American Trees and the Threat of Exotic Pests*. New York: Natural Resources Defense Council.

Chirra, F. and G.A. LaBarge. 1994. *Ohio Pesticide applicator Training: Livestock Student Workbook.* The Ohio State University Extension.

Congressional Research Service, the Library of Congress. 1999. Executive Order 13112 of February 3rd, 1999. *Harmful Non-Native Species: Issues for Congress*. Order Code RL30123. 50 pp.

CSIRO. 2002. "Common Names." CSIRO, Australia and AFFA. http://www.csiro.au/

Dowell, R.V. and C.J. Krass. 1992. "Exotic pests pose growing problem for California. *California Agriculture* 46 (1):6-10.

Drummond, R.O., Lambert, G., Smalley, H.E., and E.E. Terrill. 1981. "Estimated losses of livestock to pests." Pages 111-127 in Pimentel, D. ed. *Handbook of Pest Management in Agriculture*. Boca Raton, FL: CRC Press, Inc.

Elton, C.S. 2000. *The Ecology of Invasions by Animals and Plants*. The University of Chicago Press, Chicago and London.

Frank, J.H. and McCoy ed. 1995. "Precinctive insect species in Florida." *The Florida Entomologist* 78 (1): 21-35.

GAO. 2002. Invasive Species Clearer Focus and Greater Commitment Needed to Effectively Manage the Problem. http://www.gao.gov.

McNeely, J.A. Mooney, H.A., Neville, L.E., Schei, P. and J.K. Waage (Eds). 2001. *A Global Strategy on Invasive Alien Species*. IUCN Gland, Switzerland, and Cambridge, UK, in collaboration with the Global Invasive Species Programme.

Mooney, H.A. and R.J. Hobbs. 2000. *Invasive Species in a Changing World*. Island Press, Washington, D.C.; Covelo, CA.

National Invasive Species Council. 2001. *Meeting the Invasive Species Challenge: National Invasive Species Management Plan*. Hard-Copy Publication. 80pp.

National Plant Board. FY2004. "Eastern Region Cooperative Agricultural Pest Survey (CAPS) Guidelines". Animal and Plant Health Inspection Service (APHIS).

Pattison, R.R., Goldstein, G., and A. Ares. 1998. “Growth, biomass allocation and photosynthesis of invasive and native Hawaiian rainforest species.” *Oecologia* 117: 449-459.

Pimentel, D. 1993. “Habitat factors in new pest invasions.” Pages 165-181 in Kim and B.A. McPheron eds. *Evolution of Insect Pests – Patterns of Variation*. New York: John Wiley and Sons.

Pimentel, D. 1997. *Techniques for Reducing Pesticides: Environmental and Economic Benefits*. Chichester, UK: John Wiley and Sons.

Pimentel, D. 2002. *Biological Invasions: Economic and Environmental Costs of Alien Plant, Animal, and Microbe Species*. CRC Press LLC, Boca Raton, FL.

Pimentel, D., Lach, L., Zuniga, R., and D. Morrison. 1999. “Environmental and economic costs associated with non-indigenous species in the United States.” Cornell University. Ithaca, NY.

USBC. 1998. *Statistical Abstract of the United States 1996*. 200th ed. Washington, DC: U.S. Bureau of the Census, U.S. Government Printing Office.

U.S. Congress. 1993. “Harmful Non-Indigenous Species in the U.S.” Office of Technology Assessment. OTA-F-565. Washington, D.C: U.S. Government Printing Office.

Vinson, S.B. 1994. “Impact of the invasion of *Solenopsis invicta* (Buren) on native food webs.” Pages 241-258 in William, D.F., Ed. *Exotic Ants: Biology, Impact, and Control of Introduced Species*. Boulder, CO: Westview Press.

Wittenberg, R. and M.J.W. Cock ed. 2001. *Invasive Alien Species: A Toolkit of Best Prevention and Management Practices*. CABI Publishing on behalf of Global Invasive Species Programme (GISPb), Wallingford, Oxon, UK.

Yano, E., Matsuo, K., Shiyomi, M. and D.A. Andow. 1997. *Biological Invasion of Ecosystem by Pests and Beneficial Organisms*. NIAES Series 3, Tsukuba, Japan.

Anne Radavich's Plan of Study: Pest Risk Assessment in Corn

In the state of Indiana, and largely throughout the Midwestern United States, one of two major crops produced is corn (*Zea mays*). Corn, far more than soybeans, is persistently under attack from insects, most of which are invasive species. These include corn rootworm (*Diabrotica spp*.), European corn borer (*Ostrinia nubilalis*), corn earworm (*Helicoverpa zea*), and many others. Also, corn is a monoculture in many states in the Midwest, and exists continuously for hundreds of miles. Because of corn's history of high susceptibility to introduced insects, a new invasive species could cause major economic damage, and for this reason, prediction and prevention of the import of a potential invader is very important.

Currently, there are a limited number of restriction on importing plants and animals into the United States. Many things slip through either because that have not been proven to be harmful or their entrance into the country was not officially known or could not be detected. Most of these non-indigenous species do not become invasive, but those that do are very damaging. With the large numbers of insects that have the potential to be brought into the country by airline passengers and baggage, cargo, mail, and cruise ships alone (Venette and Ragsdale 219), it is difficult for inspectors in the ports-of-call to determine what is and is not a safety threat. This project is designed to create a risk assessment program for invasive species on corn. The program and its results would further the understanding of what particular insects should be prevented from entering the country based on known biological characteristics and the probability of damage calculated using statistical modeling programs.

Invasive species are not a new problem. Transport of biological material has been leading to the "homogenization of earth's biota" ("Ecological Predictions" 1233) since the beginning of trade. Many of the living organisms that are transported die along the way, or shortly after they are introduced into a new environment. However, those that do survive and become established carry risks of becoming a pest. These so-called pests can pose significant risks to human health, can cause large-scale economic damage, or can bring on harmful changes to biodiversity and ecosystem functions ("Progress in Invasion Biology"). With the potential damages that an invasive species can cause, they have become an unwelcome phenomenon.

Despite the negative aspects of biological invasion, Carey et. al. point out that, "biological invasion is a natural process that, like extinction, has been greatly accelerated by humans (1)." Humans and their activities perpetuate the invasions that have become so problematic today. With the increase in global trade and commerce, it has become easy to introduce, either intentionally or unintentionally, a non-indigenous species into a new habitat. Likewise, alterations in land use have increased the incidence of invasions many times over. Since trade and commerce will not stop, and changes in land use will continue, ~~so~~ it has become necessary to examine the invasive process in depth to find alternative solutions to the ever-growing problem of invasive species.

The invasive process itself is widely discussed, and while the opinions of researchers differ slightly regarding what is important to invasion, the best description of the invasive process is given by Kolar and Lodge in their paper, "Progress in invasion biology: predicting invaders." Kolar and Lodge believe that there are four major steps in the invasive process for a species: transportation, release, establishment, and spread of an organism (online pub page 3, journal pagination?). They explain that an organism must survive each step in the process to become an invader. Likewise, they point out that a trait that may greatly aid a species at one step in the invasive process could hinder it in another. Because of this, the process to becoming invasive would require a carefully balanced and very specific set of characteristics for a plant or animal to survive all four steps.

Invasion has been shown to follow general geographical trends. Vitousek et. al. studied the number of established invasive species world-wide by continent and island. They found that the number of invasive species per area increased as one moved from north to south on a continent. This trend continued until the dry subtropics were reached. They also noted that in the tropics, the level of invasion was low. However, it increased again in the southern temperate areas. With respect to islands, it is unsurprising that heavily trafficked islands showed higher numbers of invasive species than low-traffic islands, and that islands generally had higher rates of invasion than continents (2).

While geographic trends do play a role in invasion, land use is a more important aspect as it is a direct cause of some invasions. Vitousek et al. discuss how humans have-played a significant role in most of the invasive caused global change we are currently seeing saying that, "many invasions are reflections of other changes, rather than being themselves drivers of change. (6)" Humans are often altering land use and the resulting disturbances are considered the most common promoters of invasion. Alterations to accommodate recreation, agriculture and industry often create openings for foreign species that are quicker to adapt than native species. It has also been noted that species that invade after disturbances often come from areas where similar disturbance regimes normally occur (8). It has been discovered that the organisms that take advantage of disturbances can often promote further disturbance in the ecosystem. This is illustrated by the invasion of European cheatgrass into the intermountain west of North America. This particular invasion has resulted in major fires that occur every 3-5 years, due to heavy growth of flammable cheatgrass, when, previously, the same fires only occurred once every 60-110 years (8).

Other aspects of the environment may determine if a species is able to become established and later be considered invasive. Roy notes that a species is generally more invasive because the given species did not evolve in the new environment (337). Aspects of the environment may include plant species depending on mutualism with animals or soil microbiota (Richardson et. al.). For plants, pollination, seed dispersal, and root symbiosis are typically accomplished through specific mutualistic relationships. Such mutualistic relationships can act as a barrier to some plants because an integral part of their life cycle is missing. However, invasions are known to happen after the introduction of symbionts into ecosystems, as well as after the accidental importation of both plant and a given mutualistic partner. Richardson also cites ecosystems becoming prone to invasion because of the increase in the number of potential mutualistic partners, as well as because of conditions that favor new mutualistic relationships being developed between previously unassociated native species and non-indigenous invaders (85).

Ecological factors also influence invasive ability. When a species is introduced into a new environment, there is usually a lack of suitable predators or herbivores capable of consuming that species. Likewise, there may be a lack of pathogens or parasites that previously helped to control the population of the invader. Also, it is characteristic of an invader to out-compete all other species, thus causing a lack of biodiversity, possibly even driving other native species to extinction. The lack of competition allows for the rapid increase in the population of the foreign species.

Exotic species have been cited as being largely invasive by researchers (Rejmanek 1996 and 2000). Exotics often fill an existing gap in the flora and fauna that has not already been exploited. Sometimes a species is well suited to an environment but has yet to be introduced into it. For example, Williamson mentions that both Ireland and Newfoundland were geographically isolated before a number of species (including the bank vole, mink, red squirrel and snowshoe hare) could become established. Both islands should have been, by ecology and the distribution patterns of the mentioned species, inhabited, and would be highly suitable *if* the given species could reach the islands. In cases of invasion the unusual characteristic of exotic organisms can be very beneficial to facilitate establishment.

While ecological characteristics are useful in predicting invasion, biological characteristics seem to give researchers the best tools to estimate the possible invasiveness of a given species. If a set of characteristics that promote invasive success could be isolated, it would make identifying potential invaders much easier. However, very little research has been conducted with insects (Venette and Ragsdale (2004), Venette and Hutchison (1999), Williamson and Fitter (1996)). The majority of invasion work has been conducted with plants and a small amount with fish (Kolar and Lodge 2001 and 2002). The variety of possible biological aspects contributing to invasive potential is startling, but most researchers have singled out a subset that they believe to be most related to plant invasive ability.

The general consensus in plant biology has been that the three major characteristics of invasive plant species are small seed mass, a short juvenile period, and a short interval between large productions of seed, all of which are related to a small genome size (Rejmanek and Richardson (1996), Rejmanek 1996, Rejmanek 2000, Grotkopp et. al. 2002, Roy 1990). Roy also considered a high population growth rate, high reproductive allocation, seed production over a wide range of conditions, long-lived and distributed seeds, large biomass, and plasticity to be important. Rejmanek believes that general population polymorphism and fitness homeostasis play a large role in a species becoming invasive and that these are exhibited in the physiological and ecological performance of the species. Likewise, distribution by vertebrates, vegetative reproduction, and belonging to exotic genera are advantageous to a potential invader.

Some work has been done by Kolar and Lodge (2001) to attempt to find cross-taxon biological characteristics that would contribute to invasive tendencies. Kolar and Lodge seemed unable to distinguish any major characteristics that could truly be applied to generalizations about cross-taxon invasiveness. However, they did introduce a concept that none of the other authors had the idea that there might be universal characteristics (e.g. long generation, low reproductive rates) that were negatively associated with invasiveness. Under this premise it might be possible to identify poor invaders, even if it were not possible to identify high risk species.

As biological characteristics have, by themselves, not been enough to determine what species will and will not become invasive, other methods have been developed to help assess invasive potential. Williamson and Fitter discuss a general "rule of thumb" approach titled the "10's rule." This is the generalization that one in ten species imported is later seen in the wild (introduced). Of those released into the wild, one in ten will survive to become established, and one in ten of those species that becomes established will become a pest. While this rule fits most invasions fairly well, it has exceptions. For varying reasons, it is a poor fit for exotic birds, crops, insects released for biocontrol purposes, and for islands invaders.

In Marcel Rejmanek's paper "Invasive plants: approaches and predictions," he discusses five different forms of risk assessment of a given species. The first of these is the stochastic approach, based solely on randomness. This approach acknowledges that larger populations will have higher invasive success and that more attempts at colonization with larger numbers are more successful. Another approach is the empirical, taxon specific option. This option is far more selective and looks at previous information about a given taxon, such as if it contains invaders elsewhere. Some families of plants, for example Brassicacaea, are known to contain many invaders, and this information may be used as a note of caution.

Simple experimentation is possible as a risk assessment tool; however, Rejmanek points out that experimentation only deals with quarantined field trials and is problematic since many invaders require substantial time lags, sometimes a century or more, to become invasive. This makes experimentation of limited usefulness. Conversely, Rejmanek last noted two options which have, to date, proven to be the most useful. These approaches are evaluation of habitat compatibility and the evaluation of biological characteristics using statistical or model based programs.

The best example of evaluating habitat compatibility is the use of modeler programs such as CLIMEX, as carried out by Venette and Hitchison, and Venette and Ragsdale. CLIMEX is a modeling program that, for most locations, contains approximately 30 years of climatological data from around the world. With the data, it is possible to input information about a potential invader, such as moisture and temperature requirements, and evaluate the compatibility of a location for invasion (Venette and Hutchison). It is also possible to use information about a range that has been invaded and to determine the tolerances of an insect. This information can be used to backtrack and determine possible origins for invaders from unknown locales by using the association between climate of native and invaded ranges (Venette and Ragsdale).

Lastly, the technique of evaluating invasive potential by biological characteristics has shown great potential for use by industry and government. Both Kolar and Lodge, and Reichard and Hamilton have demonstrated the usefulness of this technique. Both used discriminant analysis (DA) and classification and regression trees (CART) to first determine what biological characteristics were significant, and then to combine them in a way that would be useful in determining invasiveness. Reichard and Hamilton's resulting models were then applicable for use in determining whether or not a plant should be allowed entry into the country. They also created simple decision trees to assist customs officers at the ports-of-call. The resulting model has been used by Kolar and Lodge to analyze which fish posed the greatest threat of invasion to the Great Lakes, a system already fighting economically damaging invasive species. Though facing some criticism, these models, when applied specifically, have been helpful risk assessment tools for predicting invasiveness.

A recent application of modeling has been the use by the U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine (USDA, APHIS, PPQ) to model risk assessment for the introduction of insects and plants into the United States. PPQ has been using a modeling program generally known as a Monte Carlo simulator program to determine the risk level of a species for many potential aspects of invasiveness, ultimately declaring a species as high, medium or low threat. This program uses known information about an organism, combined with unknown features. The unknown features are assigned a distribution type and then randomly sampled for by the program. The program then compiles the outcome of the random samplings and then, using this outcome, determines which outcome occurred most often. The program thus effectively predicts what would be most likely to occur. There are potential pitfalls to this system, as it has not been tested against known invaders to determine if its results are accurate. Also, it is difficult to assign a distribution to a system not yet properly understood. However, at this time, a better option does not exist.

All the available information about invasive species and the damage associated with potential invasion still leaves several questions unanswered. One of these is the observation that with some so-called invasive insect species, it is debatable if the damage caused is truly economic, or if the damage is merely social in nature. For example, the Asian Lady Beetle (*Harmonia axyridis*), Soybean Aphid (*Aphis glycines*), and the Asian Longhorn (*Anoplophora glabripennis*), all present interesting issues. The Asian Lady Beetle is considered invasive, but has no major economic impact, serving only as a nuisance. The Soybean Aphid, though novel, rarely causes significant economic damage to soybeans because it is predominantly (completely?) a foliage feeder. Unless the numbers in a field escalate to extremely high levels, no noticeable decrease in yield is usually noted. The recent introduction of the

Asian Longhorn beetle into Chicago from wooden pallets has also increased public awareness of invasive species. It attacks hardwoods, but seems to be under control. However, the damage to trees does very little to change the general economy or to alter industry.

Another interesting facet of invasive insects on crops is that the major pests almost always belong to the families Coleoptera and Lepidopteran moths (an exception being Diptera in fruit crops). Most of the crop damage is caused by the larval stages, not the adults. Most damage of note is done to root and stem/stalk, though foliage feeding can be damaging if taken to excess. With this in mind, the question may be if invasive species needs to be revised to better define priority. Some invasive species exhibit far lower levels of economic damage than others. For this reason, an assessment program would be exceptionally helpful.

Works cited

Carey, J. R., Moyle, P. B., Rejmanek, M., and G. Vermeij. "Preface." Biological Conservation. 78: 1-2 (1996).

Grotkopp, Eva, Rejmanek, Marcel, and Thomas Rost. "Toward a Casual Explanation of Plant Invasiveness: Seedling Growth and Life-History Strategies of 29 Pine (*Pinus*) Species." The American Naturalist. 159 (4): 396-419 (2002).

Hastings, Alan. "Models of Spatial Spread: Is the Theory Complete?" Ecology. 77(6): 1675-1679 (1996).

Kolar, Cynthia S. and David Lodge. "Ecological Predictions and Risk Assessment for Alien Fishes in North America." Science. 298 (5596): 1233-1235 (2002).

Kolar, Cynthia S. and David Lodge. "Progress in Invasion Biology: Predicting Invaders." Trends in Ecology and Evolution. 16 (4): 199-204 (2001).

Rejmanek, Marcel. "A Theory of Seed Plant Invasiveness: The First Sketch." Biological Conservation. 78: 171-181 (1996).

Rejmanek, Marcel. "Invasive plants: approaches and predictions." Austral Ecology. 25: 497-506 (2000).

Rejmanek, M. and David Richardson. "What Attributes Make Some Plant Species More Invasive?" Ecology. 77(6): 1655-1661 (1996).

Reichard, Sarah Hayden, and Clement W. Hamilton. "Predicting Invasions of Woody Plants Introduced into North America. Conservation Biology. 11(1): 193-203 (1997).

Richardson, D. M., Allsopp, N., D'Antonio, C. M., Milton, S. J., and M. Rejmanek. "Plant invasions – the role of mutualisms." Biological Review. 75: 65-93 (2000).

Roy, Jacques. "In search of the characteristics of plant invaders." Biological Invasions in Europe and the Mediterranean Basin. Ed. di Castri, F., Hansen, A. J., and M. Debussche. Dordrecht, Netherlands: Kluwer Academic Publishers, 1990. 335-352.

USDA APHIS PPQ. Pest Risk Assessment. USDA APHIS PPQ. 12 March, 2004. <http://www.aphis.usda.gov/ppq/pra/>.

Venette, R. C., and William D. Hutchison. "Assessing the Risk of Establishment by Pink Bollworm (Lepidoptera: Gelechiidae) in the Southeastern United States." Environmental Entomology. 28(3):445-455 (1999).

Venette, R. C., and D. W. Ragsdale. "Assessing the Invasion by Soybean Aphid (Homoptera: Aphidae): Where Will It End?" Ann. Entomol. Soc. Am. 97 (2): 219-226 (2004).

Vitousek, Peter M., D'Antonio, Carla M., Loope, Lloyd L., Rejmanek, M., and Randy Westbrooks. "Introduced Species: A Significant Component of Human-Caused Global Change. New Zealand Journal of Ecology. 21(1): 1-16 (1997).

Williamson, Mark, and Alastair Fitter. "The Varying Success of Invaders." Ecology. 77(6): 1661-1666 (1996).