Oregon State IPM Committee Report

May 2018

Oregon State IPM Committee Report

Summary and recommendations

Integrated pest management (IPM) offers a sustainable approach to addressing pest, disease and weed challenges within and among all State agencies that have land or property holdings, and/or respond to statutory responsibilities to protect, health, the environment, the state economy, or the cultural and aesthetic value of Oregon's natural heritage.

IPM is however complex and evolving, and State agencies must pursue onerous responsibilities, and respond to a high frequency of pest invasion while also attempting to stay abreast of advances in pest management approaches. We all recognize that the costs of inaction would be immense, and could affect the lives of every Oregonian, but management actions are carried out in public and can attract concerns even though very strict guidelines and procedures are followed. Agencies therefore have the responsibility to consult and engage with the public and a number of advocacy groups when their actions are perceived as clashing with diverse interests and values, and this has created a dynamic and complex environment to operate within. All the agencies take this responsibility extremely seriously, and we are seeking to define and describe IPM programs and their impacts more effectively in the future.

The State has been lacking a unified process to express pest risks in terms that make sense to the public, and also to quantify the benefits and impacts of IPM approaches that have a good track record of success in Oregon. The debate in public often revolves around pesticide use, its justification and associated risks. The Committee understands these concerns, and we have tried to address this broadly in our first report by describing our IPM approaches more fully than has been in the public domain before.

Importantly, we do understand the need to track and quantify pest and pest management (including pesticide) risks over time, but as we state below, this will require further collaborative work and investment if it is to be pursued.

The work of the Committee is going to continue and gain momentum, and there are a series of priorities that have been identified, which we seek to pursue, subject to the necessary resources being found.

1. The report identifies needs for greater cooperation and support among agencies where expertise in IPM is unevenly distributed. This cooperation is already at a high level when a new invasive pest threat emerges, but there are opportunities to address more fundamental aspects of IPM implementation. There have for example, been requests for more simplified IPM approaches that can be applied to State property and buildings that build upon the high level of expertise that exists within the State. Proposals to address this include:
    a. A State Certificate program in IPM that might be offered as a professional development opportunity for agency staff including management and the personnel that implement programs on the ground.
    b. Specialized multi-agency training programs in areas such as application of pesticides, pest prevention strategies, pest diagnosis, or pesticide selection.
    c. Cooperative working groups that might develop more harmonized approaches and guidelines that could then be pursued by all agencies where the IPM context is similar across lines of agency responsibility.
2. The impacts of IPM being adopted and implemented requires State agencies to develop metrics that can readily and repeatedly be measured before, during and after IPM programs are conducted. This represents a current frontier for IPM in general, but there is no reason why Oregon cannot take a lead in this complex challenge if the

resources can be found to enable State personnel to work with evaluation specialists on this topic.

   a. Metrics would include pest economic, health and environmental risks, as well as the risks associated with IPM practices themselves.
   b. Evaluation processes often take a three-stage approach, that address 1. knowledge, and planning, 2. implementation, and 3. system-level change (i.e. was health, the environment, or the economy protected)?

3. State agencies pursued a new mechanism for prioritizing and also tracking our responses to needs, termed IPM Strategic Planning. Although initial funding requests were not successful, this is an area that the Committee will pursue. It offers benefits for increasing efficiency in addressing the most important priorities, and the methodology can address education, research and policy needs.

Contents

Meeting Notes June 9th 2014

Meeting at ODA, Salem

Agenda

- Introductions
- Review of the Bill, and agency responsibilities and resources
- Development of a plan for topics and meetings
- Review of state agency surveys, and current needs and challenges

Present or participating by phone

Paul Jepson (OSU), Dan Hilburn (ODA), Carri Pirosko, (ODA), Tom Burrows (DAS), Randy Gengler (DAS), Kevin Masterson (DEQ), Lanny Quackenbush (DSL), Wyatt Williams (DOF), William Lackey (DOT), Curtis Cude, Noel Bacheller (OPRD), Chad Naugle (DOC), Curt Melcher (ODF&W), David Yoder (EOU), Douglas Brooke (UofO), Brian Tuck (OSU), Zachary Erdman (DOC).

The meeting consisted of a round table discussion and the comments made by each agency within the discussion are summarized here, with the order being determined by the sequence of initial contributions to the discussion by each agency.

OPRD seeks better partnerships with other agencies, and to build momentum in IPM and the methodologies associated with it by expanding training opportunities.

EOU seeks standardized IPM templates and methodologies that fit within the management constraints associated with a University setting, including ways of determining acceptable levels of pest infestation. They are currently replacing trees affected by wood boring insects.

UofO seeks on-the-ground, outcome-oriented IPM for lawns, and facilities including cafeterias. It is important to streamline processes and to include notices and communication as part of the guidelines.

OSU discussed its broad and diverse IPM programs in research and extension, and seeks greater synchronization across agencies and missions, and better ways to make the benefits of IPM clearer to the general public.

ODF&W seeks to affirm the benefits of IPM, which is implicit within its programs although not explicitly termed IPM – it is the approach that they take. They think it is important to seek greater recognition for the importance of IPM by the legislature, in order to increase the numbers of boots on the ground. In addition to wildlife management areas, it is important also to consider facilities.

ODOT takes a practical approach, based upon IPM and is always seeking review and improvement of its systems, including those associated with facilities. They also see scope for greater specificity in IPM systems to encompass challenges such as construction sites, and rail transportation.

DAS seeks as much standardization as is possible in IPM processes with clear formats, and timelines for practices, and procedures for record keeping.

ODA has very wide-ranging programs, largely not directly associated with agriculture because they focus on invasive species that can have devastating

consequences, particularly exotic insects and weeds. Exclusion would be the most effective approach if it were possible in every case, but further layers of protection are offered through recognition, early detection, and rapid response to invasions. They are seeking to have the value of this approach more widely recognized. Through the interagency noxious weeds symposium, training is provided and they are confident that there are many cost savings through better practice and skill. They seek better recognition for thoughtful decision-making, and in particular, they would like pesticide risks to be tracked through time because these have been substantially reduced and the story needs to be told. The use of *Bacillus thuringiensis* as an insect management agent for example, eliminates the use of synthetic pesticides.

DOF operations follow the Forest Practices Act and this determines the scope of their programs, which operate differently in state owned and private lands. Invasive species are their major preoccupation. IPM programs must address facilities as well and lands.

DOC works with confined adults and they have a duty of care for those in custody. As an element of facilities management, they would like to have clear definitions of IPM that can be used in procedures and in training. They would also like to provide training for contractors, and to include IPM within the procurement process for IPM in grounds and within facilities.

DEQ has programs that impinge upon IPM, particularly their work with water quality in agricultural watersheds. They also work with DAS on procurement, aligned with an executive order that requires purchase of green chemistries that pose lower risks.

The DSL focuses on noxious weeds in agriculture and rangeland, and works with DOF in managed forest lands, and they partner within Cooperative Weed Management Areas. They are concerned that firefighting operations may spread invasive weed seeds, and they also have concerns about adequate

protection of lands that are occupied by potentially listed species under the Endangered Species Act. They also seek IPM guidelines for facilities management.

Conclusions

It was agreed that the committee would seek to develop metrics for IPM adoption and IPM outcomes, and it was proposed that a national working group, that includes OSU representation, should be approached and a process of metrics development initiated.

The IPM Impacts Assessment workgroup of the National IPM Centers (http://ucanr.edu/sites/McRoberts/) was approached, but it was not possible to justify their participation in this effort within current budgets and scope.

OSU added a substantial programmatic proposal within it's extension IPM program grant submission to USDA NIFA, but this was not awarded because the funding committee argued that this work should be a funding responsibility for the State.

This process is still to be initiated as a statewide project once appropriate resources can be located.

Meeting Notes April 12th, 2016

Meeting at ODOT, Salem

Agenda

- Introductions
- Elucidation of common areas of activity and purpose that span agencies
    - Representing common themes among agencies
    - Pesticide management
    - The costs of doing nothing
- Timeline for report completion and public review
- Areas for collaborative work, IPM impact evaluation
    - Establishing a process for State agencies
    - Using information for public outreach

Present or participating by phone

Paul Jepson, (OSU), Carri Pirosko, (ODA), Kevin Masterson (DEQ), Wyatt Williams (DOF), William Lackey (DOT), Noel Bacheller (OPRD), Chad Naugle (DOC).

Common areas of activity

1. Representing common themes among agencies

The committee discussed common areas of activity and considered the following themes to be possible headings under which to provide a more aggregated State IPM report in the future. We identified agencies where a

particular theme represented a key focus, while also recognizing that all agencies could identify certain areas of their activity within each of the proposed headings.

We proposed that sub-groups of agencies compile summaries of their activities under these headings, and that areas of potential collaboration, joint work, and staff training are identified.

There are many cross-agency activities already under the banner of invasive and exotic organisms, but some of the other themes are underexplored in terms of joint agency activity.

It was proposed that OSU take the lead in coordinating a grant application to conduct pest management strategic planning with the DOC, and that all agencies would play a role in participating in this process. This process will not only identify specific needs and priorities for DOC, but also enable DOC and other agencies to better define cross cutting themes for joint activity (the project proposal is included with this report).

The major themes and cross cutting areas of priority for IPM within and among Oregon state agencies.

The agency lead or co-leads for discussion are also listed below.

These themes could each have goals assigned to them, and also incorporate metrics that quantify progress towards meeting these if an appropriate funding program can be identified (see minutes of 2014 meeting).

There would be benefits in terms of increased quantification of IPM benefits in terms of the economy, ecology, and human and environmental health of the

state, and also in terms of efficiencies that naturally arise as a product of working across agency lines to address common priorities.

PROPERTY

DAS

NATURAL AREAS, ECOLOGICAL FUNCTION

ODF&W (aquatic and terrestrial)

ODOT

DOC (wetlands and mitigation areas)

DSL

INDIGENOUS PESTS (invertebrates, vertebrates and diseases)

ODF

ODOT

ODF&W

OPRD

DOC

EXOTIC ANIMALS (marine, freshwater, terrestrial)

ODA

ODF

ODF&W

DSL

EXOTIC PLANTS

ODA

OPRD

DAS

ODOT

DSL

PUBLIC HEALTH

OPRD

DOC

2. Pesticide management

All agencies have strict policies that limit both use of pesticides and also restrict use of higher risk materials in favor of those chemicals that pose limited risks to human health and the environment.

To quantify the benefits of these policies, the agencies would need to conduct an exercise where uses and recommendations for pesticides are compared through time to track reductions in risks, and/or comparisons made with alternatives that may have been selected without these policies being in place.

There was eagerness among agency participants in the committee to conduct such an exercise, but also an awareness that resources are not currently allocated to conduct analyses of this form.

Although this analysis may allay public concerns about pesticide risks, the agencies are implementing policies that require low risk pesticides and IPM alternatives to be used, and it was agreed that greater could be expended in drawing attention to current practices in future reports.

Two areas of current agency program activity were identified as being worthy of emphasis.

- DAS procurement and purchasing guidelines, constructed in cooperation with ODEQ.
- Review processes in use my numerous agencies that constantly take into account efficacy, costs, toxicity and risks associated with different pesticides in the context of agency programs (e.g. ODOT, OPRD, ODA, ODF policy implementation).

One area was identified as being of particular interest to all agencies, a state-of-the-science approach to selection of pesticide active ingredients. Although again this would require resources to develop, and a public process to complete, all committee members are aware that science and understanding about pesticide risks and benefits is advancing, and that a mechanism is required that can incorporate the latest science as rapidly as possible.

3. The costs of doing nothing

It is a general concern of the committee that the benefits of implementing IPM and the policies that mandate this are better understood by the public and by

the legislature. We discussed using an approach favored by certain international agencies – quantifying the costs of inaction.

With respect to all organisms classified as invasive species, and even for many indigenous pests, the potential for harm, and the direct harm caused requires action if adverse economic, health or environmental impacts are to be minimized.

IPM provides a suite of tools and management approaches, which minimize the likelihood of pest damage in the first place, and which also provide approaches to respond to outbreaks and limit their effects with low risks to human and environmental health. But we asked, what if no action was taken? What data are available to define the need for IPM using currencies of pest impacts that carry meaning for the general public?

This is again a topic that requires allocation of resources and staff time, but the Committee had a number of suggestions for the conduct of this exercise.

Several sources of data may be available to construct this exercise.

- The US Forest Service conducts consultations about the costs to healthy forests of invasive species such as Gypsy moth.
- Individual parks, under the auspices of OPRD identify habitats at risk or at risk of decline.
- Parks also compile inventories of pests for each park or management unit.
- Washington DOT has undertaken cost-benefit studies, including comparisons of mechanical versus chemical IPM tactics within its programs.
- ODA undertakes economic assessments for individual species of concern, that include predictive distribution maps, and economic loss estimates (e.g. Gorse as an invasive weed in coastal parks, 2000 and 2015 assessments).

The Committee also had suggestions for certain of the criteria of costs/benefits that might be considered in this exercise. In no particular order:

- Public health benefits, where management actions by various agencies limit mosquito-borne diseases, bed bug infestations, vermin (including rats and mice), zoonotic diseases that can transfer from animals to humans, and toxic algal blooms.
- Commercial/economic benefits, where ODOTs programs for example maintain highway infrastructure that protects investments in roads, but which also underpins the economic prosperity of Oregon.
- Benefits to ecological function, where for example management of nitrogen and phosphorous prevents algal blooms, and limits opportunities for invasion of coastal and estuarine habitats by invasive species. Pollution prevention programs can also be evaluated in this regard, because polluted habitats are impaired and invadable.
- Cultural benefits, where for example, the aesthetic and therapeutic attributes of parks could be considered.

Reporting timeline

The Committee agreed to meet in May or June, by which time a draft report would be in circulation with a target of June 2016 for release for public review.

It was agreed that agencies would submit program summaries before the next meeting, as candidates for the report, and that various agencies would be highlighted in succeeding reports.

Areas for collaborative work, IPM impact evaluation

The chair reviewed funding sources for committee work, and the mechanisms for agency engagement were discussed. There are significant procedural problems for agency personal to become involved in externally funded work that involves other agencies and which does not directly address an individual agency mandate. This is understandable, but the IPM Committee might serve as a review body for opportunities as they arise. One area that was discussed, was development of a professional certificate for agency personnel involved in IPM activities, in order to provide an opportunity for professional advancement for agency staff.

The Committee agreed to investigate the USDA process of pest management strategic planning, with the possibility that one agency might serve as the host for this, and invite other agencies to participate, based upon their expertise. DOC volunteered as an agency with significant needs to develop functional collaborations with other agencies, and it was agreed that this would be pursued before the next meeting of the State Committee.

It was again agreed that a formal, funded process is required to determine appropriate metrics for IPM program impact evaluation that can be aggregated from individual programs, to separate agencies, to all agencies combined.

Meeting Notes May 23rd, 2016

Meeting at ODOT, Salem

Agenda

- Introductions
- Pest Management Strategic Planning – Katie Murray (OSU), Chad Naugle (DOC)
- Review and updates previous meeting
- Development of state report, and agency critical needs

Paul Jepson, Katie Murray (OSU), Carri Pirosko, (ODA), Kevin Masterson (DEQ), Wyatt Williams (DOF), William Lackey (DOT), Noel Bacheller (OPRD), Chad Naugle (DOC).

Pest Management Strategic Planning (PMSP)

Katie Murray reviewed the planning process, which is recognized by USDA and USEPA as a key source of information about IPM needs in research, education and policy. Completed plans are posted to a national database (https://ipmdata.ipmcenters.org/source_list.cfm?sourcetypeid=4) and used in prioritization for research and extension grant support and in regulatory changes for pesticides that reflect specific use practices.

The Committee agreed to pursue a grant application to the Western IPM Center for a PMSP that would identify needs within the DOC. (Grant application attached).

Further discussion about areas of common interest for the report

Under the general theme of "costs of inaction", the discussion from the previous meeting was expanded upon.

The committee concluded that this approach would be worthwhile, but would require new resources to be able to undertake it effectively. Many possible examples were apparent, for example, specific pests such as Dendroctonus bark beetles, which can colonize up to 400,000 acres of forest annually, and where ODF has compiled management guidelines that maximize forest resiliency and minimize environmental impact of possible control measures. There are many examples of carefully constructed management plans that conduct environmental assessments, and develop IPM strategies that reduce or eliminate severe pest risks.

There are also broader benefits of IPM and invasive species management approaches that have not been quantified to date. These include for example, wild land fire suppression programs that eliminate flammable invasive species. Reduced fire loading is an important aspect of healthy forest management, but it also correlates directly with the respiratory health of hundreds of thousands of Oregonians. Invasive pathogens such as Sudden Oak Death also thin and weaken forest stands, and if management plans are not implemented, the flammability of forest lands increases, with consequences that go well beyond forest boundaries.

In parks, Gorse invasion is, for example, reducing habitat that is suitable for the colonization by invasive species in coastal areas. Sage grouse habitat is also threatened by cheat grass in E. Oregon, and ODF&W programs address this risk.

Finally, ODEQ expanded upon the value of setting standards for water quality that can be operationalized through agricultural water quality management plans – the benefits of this in terms of healthy aquatic ecosystems and survival of Salmonidae for example, has not been quantified on a statewide scale.

Under the theme of pesticide management, the Committee again distilled a large number of specific cases as well as policies, where risks to human health and the environment are minimized. ODEQ identifies compounds of concern in surface waters based upon detailed residue analysis and information about risks to human consumers and to aquatic life. These approaches, where compounds for removal and replacement are identified, has permeated numerous agencies, and water quality management plans, developed by ODEQ and ODA are instrumental in preventing excessive loadings of pesticides in surface waters.

Critical needs that have emerged as a result of the Committee process.

A round table review determined that pesticide selection was a key topic of interest in every agency.

ODOT requested an informal scientific meeting to examine the state of the science in pesticide selection based upon current knowledge of risks and benefits.

DOC considered that having adults in custody involved in IPM programs, including technically complex areas such as pesticide selection would provide employment opportunities when individuals rejoin society. It also considered

that better procurement guidelines would emerge from the process that ODOT suggested.

ODF emphasized that it is fully committed to IPM and that it anticipated a continuation of the increased threat from novel invasive species. Of 67 tree species where data are available about pest threats, one third are currently affected by invasive species. The work of the Committee is critical in further developing these programs in a cooperative and coordinated way.

ODEQ is interested in greater emphasis on impact assessment, particularly ecological impacts of pesticides, where there has been insufficient analysis in the past.

OPRD supported the idea of capacity building around pesticide selection and the development of a uniform set of best management practices (BMPs) that can support decisions among state agencies and also assist in quantifying benefits to the ecological services that our programs serve to protect.

ODA has very significant expertise and case examples to provide, and also capacity to assist in developing guidelines that expand best practices, IPM and impact assessment among state agencies.

Conclusions.

A PMSP grant was submitted to the USDA Western IPM Center, but it was not funded. There was again a concern that the State should be responsible for funding programs that are to improve processes within it's own agencies. The PMSP process could however enter the USDA national database and become incorporated in the same way as other PMSPs if the necessary resoures can be found.

At this meeting, the Chair reported that he was involved in managing a family health crisis and that this might delay the process. The report has subsequently been delayed, and the Chair takes full responsibility for this. The agencies themselves have met all the deadlines and participated fully in the process and an agenda for continued work is evident from meetings of the Committee.

State IPM Program Summary

We summarize the scope and content of agency Integrated Pest Management (IPM) programs in Oregon. This summary is derived from a questionnaire that was circulated to state agencies in 2010, 2015 and 2016. We identify major themes and programmatic content while not attempting to address every detail of this highly diverse and challenging process.

Agency IPM is evolving constantly in the face of new and emerging pest problems, and our summary should be read as an overview that provides context for discussion and programmatic development.

Background

Pest problems are highly diverse in Oregon. Multiple agencies may contribute to the overall management of some widely distributed pest species, particularly invasive plants, but they also have specific remits that require them to take the lead in management of individual pest species, such as marine organisms that affect fish hatcheries.

We are vulnerable to pest invasions across our borders and via ports of entry. Any and every habitat, including built structures, and the most isolated forest or desert locations, may provide the backdrop for IPM activities. This requires vigilance, flexibility, a capacity for on-the-ground partnerships with landowners and private industry, and an understanding of both the costs and the benefits of different IPM program options.

Whether or not, and how, an agency responds to a new problem is determined by its jurisdiction, statutory authority, and underlying legislative and authorization processes. The rate of change in the nature of pest risks and the rapidity with which IPM evolves to meet these challenges far exceed the

capacity of the legislative process. Those tasked with meeting pest threats within each agency are constantly adapting their programs and processes to meet the remit of their agency and respond also to rapidly shifting societal goals regarding the outcomes for, and technical content of IPM programs.

Flexibility to respond in an adaptive way to new IPM challenges is key to the future success of Oregon IPM programs. Oregon's state-agency IPM activities have shifted from a pest control focus, largely confined to agriculture, forestry, and the maintenance of commerce, particularly through a functional road network and navigable waters, to a pest management focus that recognizes Oregon ecosystems and the services that they provide. The pest management focus balances the economic goals of IPM programs, with goals for human health and environmental protection and the maintenance of important cultural values.

The IPM programs that we summarize in this report can only partially be predicted from the legislative authorities that underpin them. The program that emerges in our joint analysis is a product of the professionalism of agency staff, mediated by formal and informal feedback and consultation with stakeholders, the public, elected representatives, and fellow professionals worldwide.

Key Pest Management Challenges

Invasive noxious weeds are managed by multiple agencies and probably constitute the most concerted effort contributing to the missions and statutory authorities in several agency jurisdictions.

Oregon Department of Agriculture (ODA) plays a direct role in invasive species management via its program of early detection and rapid response that may bring about eradication of invasive threats if they addressed early,

and comprehensively enough. Examples of such threats include African rue, Peterson's curse, purple loosestrife, and Spartina.

ODA has a world-wide reputation for their invasive plant biological control program, and have deployed 74 biological control agents against 29 target invasive species including toad flax, field bindweed, purple loosestrife, and diffuse knapweed. ODA also acts in support of important agricultural industries that are active in national and international trade pathways that help to sustain the Oregon economy. This includes monitoring and certification of nurseries to address diseases such as sudden oak death, and also certification of commercial seed to limit contamination by invasive species.

More indirectly, ODA plays a role in invasive species management via registration of pesticides that can be used in critical situations without undue risk to human health and the environment. It also licenses pesticide applicators, and administers a program of continuing education credits for applicators to ensure that pesticide use is conducted as effectively and safely as possible. This is backed up by compliance investigations that address complaints about pesticide use. Finally, through the State Weed Board, ODA implements a weed severity classification system in reviewing and distributing grants funds for weed management projects. Grant requests are evaluated on the basis of IPM criteria, thus ensuring that pesticides are only used in those circumstances where they are most needed.

Oregon Department of Forestry (ODF) is responsible for invasive species management in State forests to maximize successful reforestation, and it conducts applied research and also monitoring projects to maximize the effectiveness of this program. ODF also provides technical assistance for invasive species management to ensure compliance with natural resource protection laws and it participates in federally funded forest health projects.

ODOT, within has responsibility to manage highway vegetation in such a way that travel safety is maximized and the road structure is protected, and within this mandate it also manages invasive species that exploit roadways just as humans do. In doing this, it ensures legal compliance with a number of statutes, but also minimizes erosion, protects habitats for the native flora and wildlife, and provides stewardship for Oregon's scenery.

OPRD addresses threats to native ecosystems, and also threats to the health and safety of the public. Invasive species management on OPRD properties often involves native ecosystem restoration, habitat restoration for at-risk plant and animal species, and control or eradication of noxious weeds and pests that pose risks to public safety or infrastructure.

DOC has responsibility for wetlands and other protected areas that fall within its jurisdiction and properties, and this must include management of invasive species that might threaten habitat integrity. It is also manages farms and on-site facilities that are subject to invasive species threats.

Other invasive species: The State Department of Fisheries and Wildlife (OD F&W) has authority to remove non-native fish species to restore ecological function and provide benefits to native fish, game fish and/or to enhance recreational angling It is also responsible for management or eradication of terrestrial species such as feral swine, red-eared slider, snapping turtle, bullfrog, mystery snail, zebra and quagga mussels. These invasive species compete with Oregon indigenous wildlife species, and can cause significant economic damage.

DSL is responsible for prevention of invasions by non-native marine organisms and for managing invasions to Oregon estuaries. They are also responsible for managing pests that affect the ecological health of state lands, particularly those that generate revenue for the Common School Fund, including pests that affect forest regeneration.

ODA and ODF are responsible for management of non-native, invasive species other than weeds, including particularly insects such as gypsy moth and Japanese beetle. This can include biological control, for example in the case of cereal leaf beetle and it's wasp parasites in agricultural systems.

OPRD responds to and manages invasive animal species where necessary. Species that sometimes require action include nutria, feral cats, bedbugs, fleas, rats, and mice.

Other pests, diseases and weeds: All agencies have responsibilities in statute or simply as managers of the land and structures they directly manage, to respond to pest outbreaks for not only invasive and exotic pests, but also established, indigenous pests, diseases and weeds.

ODA, ODF&W, ODOT and ODF have equivalent responsibilities under statute for the management of established pests to those that apply to invasive species. Management programs for these organisms can be focused on long-term and sustainable pest suppression. For example, OD F&W manages weeds and insects damaging native vegetation on wildlife areas, and also those infesting crops planted for wildlife benefit. Reed canary grass, Himalayan blackberry, purple loosestrife, medusahead and cheat grass will remain continuing threats to biodiversity, ecological function and productivity for example, and all agencies try to coordinate on an ongoing basis to minimize the potential for harm associated with these, and other species.

Oregon Parks and Recreation Department (OPRD) must address the potential for conflict between park operations and vertebrates including black bear, nutria, rattlesnakes, and ground squirrels.

Models of IPM implementation, goals and performance metrics

ODA

Model for IPM implementation:

ODA focuses upon exclusion and prevention, starting with a quarantine and "early detection, rapid response" (survey, detection, eradication and monitoring). Preventative strategies minimize risks to human health and the environment and they are the most economically sound approaches.

Examples include a weed free forage certification program established with US Forest Service.

Key goals:

ODA's goal is to prevent pests, plant diseases and weeds from entering the state. Priority weed species including the 100 Most Dangerous Invaders list, maintained by the Oregon Invasive Species Council (OISC), and the State Noxious Weed List maintained by the State Weed Board set priorities and offer guidance. Two thirds of the dangerous invaders list fall within ODA's mandate.

IPM Performance metrics:

ODA activities in IPM strive to meet state benchmark #90 – "number of the top 100 plant pests, diseases or weed species excluded each year". The OISC publishes a report card showing how well invasive species are being excluded – with a target of slowing the rate of establishment to less than one per year – which has been achieved every year to date.

ODF

Model for IPM implementation:

IPM is broadly integrated within IPM activities, although there is no explicit IPM program. ODF works with the US Forest Service in the nation's longest running (60+ years) aerial statewide survey of forest insect and disease activity.

The Forestry Program for Oregon represents the Board of Forestry's overarching policy document, and it encourages state and federal agencies to closely monitor and aggressively act to prevent and mitigate effects of invasive, non-native species in Oregon's forests. It also includes the goal of protecting, maintaining and enhancing the health of Oregon's forest ecosystems, watersheds and airsheds within a context of natural disturbance and active management.

More specifically, in State forest management, policies include a requirement that "Healthy forests will be provided by managing insects and disease through integrated pest management; and utilizing appropriate genetic sources of forest tree seed and tree species in regeneration programs." Procedures and guidance documents specify who is responsible, typically the forester or supervising forester, and provide guidance on how to meet this policy.

In the Private forests program, guiding principles are laid out in statute and rules. These include:

- Encouraging voluntary use of IPM in alignment with landowners' own management objectives. Use of pesticides is one of a variety of IPM tools that landowners may use.
- The law also provides a mechanism for requiring forest landowners to implement pest prevention and suppression strategies consistent with their management objectives.

- The State Forester is required by law to conduct surveys and evaluations on nonfederal forestlands to determine the presence, extent, trend and impact of native and exotic pests, as well as overall forest health monitoring.

The Department uses the following approaches in alignment with IPM components, as specified by law:

- Routine detection and monitoring of pest populations and damage levels, in partnership with other public and private entities.
- Developing potential strategies, including through Board of Forestry work plans, membership in the Oregon Invasive Species Council, encouragement of the addition of IPM elements into landowners' management plans, and other activities.
- Implementing strategies, through means including collaboration with other public and private entities, delivering federal cost-share programs to promote healthy forests, and supporting landowner voluntary programs for IPM and invasive species control.
- Research and monitoring, including participating in the Pesticide Analytical Response Center, leading and collaborating on research programs that test the implementation and effectiveness of prevention and control programs, and conducting or working with others on projects to monitor water quality outcomes of pesticide use.

Key goals:

On State managed forests, the ultimate goals are to achieve greatest permanent value for Oregonians on Board of Forestry-owned lands, and to manage Common School Forest Lands, owned by the State Land Board, to maximize revenues consistent with protecting environmental values. IPM can help achieve these goals by minimizing the impact of forest pests in an

environmentally and economically sound manner to meet site-specific management objectives.

It is the policy of the State Forests Division to conduct reforestation, tree improvement, and young stand management activities by applying the Forest Practices Act (FPA) standards, at a minimum, and an extensive set of specific goals including:

- Basing reforestation and young stand management activities on sound technical silvicultural principles, and
- Conducting reforestation and young stand management activities to comply with the objectives of the forest management plans.

In the Private forests program, the Department encourages economically efficient forest practices and the maintenance of the social, economic and environmental benefits that forests provide to all Oregonians. ODF supports this goal through the delivery of incentive programs, education and technical assistance to private forest landowners, and through the administration of an efficient and effective Forest Practices Act (FPA).

Specific to the use of pesticides (one of many IPM tools), the FPA seeks to ensure that:

- Pesticides used on forestland do not occur in the soil, air, or waters of the state in quantities that would be injurious to water quality or to the overall maintenance of terrestrial wildlife or aquatic life; and
- Riparian management areas and sensitive resource sites receive adequate protection during herbicide applications.

IPM Performance metrics:

The Board of Forestry, with guidance from a broad-based advisory group, has endorsed 19 indicators of sustainable forest management. Several touch on topics related to IPM, including:

- Compliance with forestry regulations focused on resource protection, which include rules on use of chemicals.
- Biological integrity of forest streams, with a desired trend of stable or improving indices of integrity. **NOTE:** This indicator is not tied specifically to the use of pesticides, but is an integrator variable that would be sensitive to harmful levels of pesticides (or other management actions that can affect invertebrates). If this indicator showed decline, the next step would be to determine the causal agent, which may be pesticides or any number of other factors.
- Tree mortality from insects, diseases, and other damaging agents, with a desired trend of stable or decreasing mortality levels
- Invasive species trends on forestlands, with a desired trend that no invasive species on Oregon's 100 Most Dangerous List are uncontained in the state's forests, and a stable or decreasing forest acreage is affected by invasive species.

An Oregon Department of Forestry key performance measure also applies: "Percent of aerially surveyed Eastern Oregon forests that are free of insect damage."

Additionally, voluntary forest landowner measures in support of the Oregon Plan for Salmon and Watersheds include various measures to control invasive species and improve forest health.

In the State forests program, a standard is to conduct two surveys of reforested units between planting and the sixth year of a plantation. Part of this evaluation is for plantation condition in comparison to the desired

condition. This process includes assessment of the effectiveness of strategies used.

Contract compliance inspections and post treatment inspections also provide immediate feedback about treatments applied or forgone.

ODF&W

Model for IPM implementation:

Hatcheries and Fisheries

a. Identification – identifying the type of predator(s) is used in determining if deterrence is necessary and if so, the method of deterrence to be used

Prevention – anti-predation structures such as net coverings for ponds, overhead lines, and electric fencing are used to prevent predators from gaining access to fish. Public outreach and signage are important tools used to protect fisheries and native populations.

Control – In the case of persistent predators that are not protected under federal or state law, a removal permit from the district wildlife biologist is applied for and the predators are removed by hatchery personnel or by Wildlife Control Operator (WCO) in the case of fur-bearing mammals. Mechanical removal by means of capture or trapping followed by sorting of fish populations to physically remove undesirable species is one method used to reduce populations. In limited cases, the use of piscivorous fish may be used to control undesirable populations. ODFW is also looking at the use of stocking YY-males to diminish the spawning success of the target species.

b. Whether or not to treat a waterbody with rotenone to remove unwanted species of fish is determined on a case by case basis depending upon a variety of factors including ownership, limnology, past success or failure, species in question, cost and potential for fishery or ecological benefit. Rotenone use is regulated and alternatives must be evaluated prior to

implementation, this includes considering mechanical removal, biological control, and other viable control methods.

Wildlife

Identification – identify the species of weed or pest, the extent of infestation and determining the best method of control; identify the aquatic invasive species or burrowing mammal and the appropriate removal method; work with local vector control districts to determine presence of mosquitoes.

Prevention – cleaning equipment to prevent spread of weeds (ATVs, heavy equipment used in stream restoration); using weed-free feed at elk and deer feeding stations; planting native vegetation seed mixes at habitat restoration sites; cleaning boats and gear used in aquatic environments; a manadatory watercraft inspection and decontamination program at Oregon border highways, jointly administered by ODF&W and Oregon State Marine Board (OSMB), to address aquatic invasive species coming from other states.

Control – For weeds and insects, typical treatment methods include applying herbicides, pesticides and bio-controls (beneficial insects) as well as habitat manipulation such as manual cutting, mowing, disking and prescribed burns. In the case of furbearing mammals that are not protected under federal or state law, a removal permit is requested from the district wildlife biologist and the mammal is removed by wildlife area personnel or by a WCO. A feral swine eradication program, administered by ODF&W, has been created to address feral swine statewide. Use of copper sulfate crystals by licensed applicators to treat mystery snails.

Key goals:

Fish

a. Reduce excessive loss of high value fish to predation and limit opportunities for predators to introduce pathogens to the rearing environment at hatcheries.

b. When using rotenone the goals are to restore ecological function and/or fishery benefit.

Wildlife

Reduce conversion of native habitats to weeds; reduce destruction of habitat by insects and swine; reduce vectors that could spread disease; reduce impacts of burrowing mammals to infrastructure, particularly in wetland habitat; reduce the potential establishment of aquatic invasive species transported by boat from other states.

IPM Performance metrics:

Fish

a. Monthly hatchery pond management reports – provides an estimated number of fish in each pond based on the original number of fish ponded and the cumulative mortality.

Liberation Reports – shows numbers of fish released or transferred from each pond

Comparison of estimated ponded fish numbers and actual numbers released or transferred is used to calculate any shortage of fish due to unrecorded loss due to predation.

Monthly progress reports – reports excessive predator activity.

Fish Loss Report – reports of excessive fish loss and causes of loss.

Quarterly Predator Loss Reports – reports accidental mortality of predators at each hatchery due to entrapment in anti-predation structures as well as other sources of predator mortality such as removal by trapping.

b. When using rotenone, periodic surveys are conducted to determine presence or absence of target species.

Each project is developed with an implementation plan, alternative analysis and a pesticide spill/contamination abatement plan. A completion report is conducted to account for the volume of product used, any safety or spill incidents, and estimated numbers of fish removed.

Completion reports are compiled into an annual report of rotenone use in the State for submission to DEQ as part of our NPDES 2300 Pesticide General Permit.

Wildlife

During spring and summer, surveys are conducted by wildlife area staff to identify weed and pest infestations; dikes and levees are visually inspected. Wildlife area managers work with local vector control entities to place mosquito traps.

Annual reports are submitted to granting entities (USFWS Federal Aid, ODA, etc.) describing weed and pest eradication activities, providing the methodology used and the number of acres treated.

ODOT

Model for IPM implementation:

The ODOT Integrated Vegetation Management (IVM) model defines "Integrated pest management" as a coordinated decision-making and action process that uses the most appropriate pest control methods and strategy in an environmentally and economically sound manner to meet agency management objectives. Vegetation is maintained in an economically feasible manner, while protecting employees, the traveling public, wildlife and the environment. Key elements include using an integrated approach that utilizes all methods available singularly or in combination to ensure the use of the right tool in the right place at the right time. This flexibility allows ODOT maintenance managers to effectively utilize resources (labor, equipment, materials, budget) for vegetation management activities.

ODOT manages vegetation along the highway right of way for these primary reasons:

- Safety
    - Maintaining clear zone. The clear zone is a barrier-free recovery zone adjacent to the roadway. The width of the clear zone varies according to highway.
    - Maintaining sight distance including sight lines around curves, to increase visibility of animals, people, signs, guardrails, and vehicles entering the right of way.
    - Reducing fire hazards.
    - Removing vegetation that may cause shading resulting in icy patches on the roadway.
    - Removing Hazard Trees. Hazard trees are those that are weakened, unsound, undermined, leaning or exposed that have potential to impact the highway.
- Protecting road prism structure.
    - Maintaining vegetation-free shoulders and cleaning ditches to provide for proper drainage of water away from pavement and road prism.
    - Reducing plant root damage to pavement.
- Stewardship
    - Open view to traveling public.
    - Maintain habitat for wetland and other native plants.
    - Consider habitat for wildlife beyond the clear zone.

    - Control erosion.
- Legal Compliance
    - Integrated Pest Management, State Statute
    - Noxious weed laws.
    - County and City Ordinances.

Guiding Principles

- Maintain a safe, effective transportation system.
- Protect human health and minimize impacts to the environment and natural resources
- Control vegetation in a manner that is cost effective and protects worker safety

Key Elements

- Encourage continuous program improvement
- Utilize more than one method of vegetation control when doing so increases effectiveness.
- Take advantage of research and new methods for vegetation control
- Evaluate and be familiar with management alternatives in order to use the right tool in the right place
- Maintain adaptive and flexible statewide and district IVM plans
- Comply with state policy for noxious weed abatement
- Comply with local ordinances, state and federal regulations
- Incorporate elements of the IVM into planning, construction, maintenance and operations of the ODOT transportation system
    - Aim for the establishment of native plants or low-maintenance landscaping and roadside plantings
    - Control weeds during construction and minimize soil disturbance to the extent practical

- Provide training in order to maintain a professional, able staff and to stay current with technological advances in vegetation treatments
- Prevent pest problems in the first place via planning, project development standards and specifications, and routine maintenance practices
- Monitor program effectiveness during daily, routine road patrol and other driving by maintenance personnel
- Program coordinator provided to oversee program, provide bi-annual training, evaluate statewide effectiveness, and modify program as appropriate
- Provide for notifications of herbicide use to the public
- Develop and implement best management practices to reduce adverse effects of vegetation management on the environment, the traveling public, and worker safety.

  Some examples of best management practices are:

  - Mowing –
    - Adjust mowing widths and heights to avoid impacts to wildlife.
    - Limit mowing to a minimum of six inches to avoid scalping the ground, which could result in soil erosion.
    - Alter the timing for brush mowing so that it doesn't coincide with prime migratory bird nesting season when feasible.
    - Alter timing for mowing to encourage the re-seeding of native plants and/or listed threatened and endangered plants.
  - Biological Controls –
    - Only release bio-control agents approved by the Oregon Department of Agriculture.

        - Document locations of bio-control releases.
        - Avoid mowing areas where bio-controls have been released.
    - Cultural –
        - Clean equipment before moving to another site.
        - Utilize weed-free seed and mulches.
        - Encourage establishment of native plants where feasible.
        - Encourage Adopt a Highway for Weeds.
        - Evaluate cost effectiveness and maintainability of weed barriers.
        - Use pilot projects to evaluate alternative methods, such as no-spray
    - Chemical –
        - Applicators must be certified and licensed according to ODA standards.
        - Applicators must follow products EPA label directions.
        - Apply the least toxic herbicides to meet vegetation management objectives.
        - Utilize "General Use" herbicides, wherever feasible.
        - General Use herbicides, as classified by the EPA, should not harm people, animals, or the environment when applied according to label directions.

The ODOT IVM program, as outlined below:

(a) Preventing Pest Problems

Roadsides are commonly the location where many noxious and invasive plants establish. Weed seeds are spread by ODOT construction and

maintenance activities, by the wind, motorists and from adjacent property owners. For both construction and maintenance activities, weed prevention specifications have been established for vehicle washing, and for the utilization of weed free seed mixes and erosion control material. Another important prevention component is the maintenance of a vegetation-free road shoulder. The maintenance of a vegetation-free road shoulder provides for adequate drainage, but also acts as a first line of defense for noxious weed control. In addition, through project development, planting schemes have been adopted to lower maintenance requirements including planting low growing trees and shrubs, and utilizing native plant material.

Annually, each of the 14 ODOT maintenance districts prepares an IVM plan that describes the vegetation management activities that will take place on the ODOT right of way within that district. The annual update of IVM plans allows for a review of the program including changes in laws or policies, reports of successes and failures, updates in ownership changes, and reviews of management practices. A general IVM plan template has been developed to give guidance to maintenance personnel as well as to promote statewide consistency.

(b) Monitoring for the Presence of Pests and Pest Damage

Roadside vegetation conditions are monitored on a daily basis by ODOT personnel as they drive their sections and perform other maintenance activities. Incorporating vegetation monitoring into other daily routine maintenance inspections allows for early detection and resolution of problem areas, rather than just relying on an annual review. The ODOT statewide vegetation management coordinator also schedules roadside tours to rate and evaluate vegetation. Outside entities such as the Oregon Department of Agriculture (ODA), county weed personnel, and private citizens also provide information regarding unwanted vegetation.

(c) Establishing the Density of the Pest Population to Warrant Treatment

ODOT manages roadside vegetation based on the established ODOT Level of Service classification system. The LOS program classifies individual highway sections and describes the threshold for unwanted vegetation. For example, Interstate 5 has a higher level of service classification than highway 47, and thus requires more vegetation management. In addition, adjacent land use, city ordinances that establish the appropriate mowing height for fire control, varying road characteristics such as sharp curves, steep slopes, or landslide-prone areas, may also dictate the appropriate level of vegetation management on a local level. Such information is outlined in individual District IVM plans, which are reviewed and updated annually.

ODOT complies with Oregon's Noxious Weed Policy to determine the acceptable density of noxious weeds. All A-list plants receive zero-tolerance management. The acceptable density of plant species on the other noxious weed lists is established via coordination with the ODA or the appropriate county weed board.

(d) Treating the Pest

In an integrated approach, the ODOT vegetation management program utilizes, singularly or in combination, mechanical, biological, cultural and chemical treatments. Mechanical control treatments include mowing, removal by hand and shoulder-blading. Biological control, in direct coordination with the Oregon Department of Agriculture, involves the release of insects, mites or pathogens to control vegetation. Cultural control includes reseeding disturbed areas, replanting after tree removal and in isolated cases could include controlled burning. Chemical control includes the use of herbicides to manage vegetation. ODOT applicators are certified and licensed according to ODA standards. The herbicides are applied according to product label requirements approved by the EPA.

(e) Evaluating the Effects and Efficacy of Pest Treatments

Evaluating the effects and efficacy of pest treatments occurs similarly to the monitoring process listed above. Successes and failures are noted and the treatments are modified for improvement. The ODOT IVM program is constantly evolving as new technology or new techniques are developed.

Key goals:

ODOT's IVM goal is to maintain a safe highway for the traveling public while avoiding and/or minimizing impacts to the environment and human health, protecting worker safety, and by making cost effective decisions to meet management objectives.

ODOT continually evaluates current practice, new technology, research documents, and other information to ensure alternative methods are considered and the most effective tools are available and utilized to the extent practical.

ODOT is committed to the preservation of the highway and providing for a safe means of travel for the public, in a manner that protects public safety, worker safety, that is cost effective, and that avoids and minimizes impacts to natural resources. ODOT continues to evaluate herbicides to ensure the least toxic chemicals are used when herbicides are considered the appropriate tool to meet management objectives.

Allow for adaptive management to modify techniques as needed to maintain a cost effective and appropriate response to vegetation management.

In 2015 ODOT successfully met a 25% target reduction in the amount of herbicides used to manage the highway for safety and for structure preservation. The strategy included an evaluation of how that reduction affects highway management. The path for development and implementation was as follows:

- An internal working group was developed to determine a herbicide reduction strategy:
  - The strategy should ensure that changes are economically and practically feasible and don't compromise level of service in vegetation management or other maintenance responsibilities.
  - ODOT will continue to support a level necessary to fight the establishment and spread of noxious weeds.
  - ODOT plans to continue to evaluate new management strategies gleaned from research projects and on-the-job learning by sharing information at statewide forums, and adopt new techniques as appropriate.
  - ODOT will study equipment efficiencies and will recommend trial use as appropriate.
  - ODOT will evaluate ways to decrease the amount of herbicides used and implement strategies as appropriate.

Current ODOT practice is to take a multi-pronged approach to vegetation management and use the right tool in the right place at the right time to ensure the cost effective use of public dollars to maintain a safe highway. ODOT stays abreast of changes in technology and evaluates new chemicals to ensure the least toxic chemicals are used to meet management objectives. Best management practices require ODOT to follow Environmental Protection Act (EPA) labels to avoid and minimize impacts to natural resources and public health. Chemicals are used only for their intended use. All ODOT applicators are certified and licensed by Oregon Department of Agriculture standards and requirements. Annual training ensures current knowledge of applicators.

IPM Performance metrics:

ODOT IVM program effectiveness is assessed in the following ways:

- Effectiveness of treatments – A roadside level of service review is performed annually by ODOT maintenance managers. The level of service review evaluates all roadside maintenance including vegetation management. Daily inspections are performed on an informal basis as part of daily roadside maintenance activities.
- Safety – Regional audits at maintenance yards evaluate proper storage and disposal methods. Regular job hazard assessment surveys are solicited for specific activities. IVM topics at safety meetings are tracked.
- Cost – Expenses are tracked on a daily basis. Employee time sheets record information regarding activities performed, daily accomplishments, equipment utilized and materials used. Monthly, yearly, and biennium reports are available for managers to review.
- Complaints – Complaints from citizens are tracked through the "Ask ODOT" system. The complaints are logged and forwarded to the appropriate ODOT maintenance section. Types of vegetation complaints include sign and visibility obstructions, drainage problems, noxious weed infestations, weed contamination of neighbors' crops, and herbicide use concerns.
- Legal Compliance – Daily spray reports that record the type of herbicide used and the location, are completed and sent to the ODOT Office of Maintenance. These reports are entered into a statewide database used to track herbicide use. The reports are reviewed annually by the ODOT statewide IVM coordinator and are useful in responding to complaints. In addition the Oregon Department of Agriculture conducts regular audits of ODOT daily spray reports.

DSL

Model for IPM implementation:

- Rangeland: Ecologically Based Invasive Pest Management (EBIPM)-an approach that initially understands specific management issues that has caused weeds to be present on site. This approach uses basic ecological principles to guide decision-making, while integrating a plan for restoration.
- Forestlands: Generally accepted best practices for IPM.
- Submerged and Submersible Lands: Similar to rangelands.

Key goals:

- Reduce spread of noxious weeds while treating new populations as they are discovered.
- Secure funding for sustained weed and pest control over time.
- Ensure robust reforestation of Common School forestland.
- Enhance early detection and monitoring efforts.

IPM Performance metrics:

- Continued-repeated monitoring over several years showing reduction in weed composition with an increase in desired species composition.
- Regular reforestation surveys (a.k.a. free to grow)

OPRD

Model for IPM implementation:

The department's IPM focuses on weeds and animal pests that pose a risk to safety or park operations and infrastructure.. The OPRD IPM was developed in accordance with the model provided by ODA.

Key elements: each park management unit must develop their own site specific IPM to address local conditions and species issues. Management unit IPM plans are developed based on the agency template for these plans.

Guiding principles:

The mission of our Integrated Pest Management Program is to control pests that are harmful to the health and safety or to the ecological health or aesthetic value of Oregon Parks and Recreation Department landscapes and natural areas in a manner that is cost-effective, safe, and environmentally responsible. OPRD is charged with maintaining its landscape in a safe, attractive, healthy, and useful condition.

OPRD recognizes it's responsibility to protect and preserve the economic investment in the park system to the best of our abilities. We also recognize our responsibilities to our employees, park users, and the general public. We employ the highest professional standards in the performance of our duties.

The agency endorses the use of the principles of Integrated Pest Management in managing park property. This concept approaches pest control through multi-faceted strategies, which minimize the impact to the environment and human health.

OPRD's IPM strategy emphasizes prevention, cooperation, education, inventory and design management techniques. It is based on a statewide IPM as a blueprint and coupled with OPRD statewide invasive species committee as a guiding advisory body.

Key goals:

Goal: Cost effective management of invasive and pest species while minimizing impact on non-target species and use/release of pesticides in the environment.

Key outcomes:

- Minimize any negative impact on human health and the natural environment.
- Public outreach and awareness.

IPM Performance metrics:

- We require licensed contractors (cooperative agencies and local weed control districts) to report any pesticide application, quantities, location and conditions.
- Pesticide application by trained staff includes record keeping for type, quantity and conditions.
- Evaluation of effectiveness for multiple control methods: herbicide applications, mechanical methods, mulching and biological controls,

DAS

Model for IPM implementation:

Monitoring for pests, evaluating past experiences and implementing the least toxic approaches, exclusion where practical, mechanical non-chemical controls, EPA botanical and exempt chemicals and low impact chemicals.

High impact chemicals only when all other options have been eliminated.

Since 1979 DGS/DAS has used no restricted use pesticides.

Since 2000 DAS has dropped power equipment and the self-use of most insecticides, with the exception of wasp spray in home-owner cans, which have potential human life safety risks. We no longer use any products requiring respirators.

Key goals:

Control of pests (pests in our broad view are weeds, insects, animals and fungi) within the acceptable thresholds of tolerance for the given pest. Best protections possible for control of a given pest while allowing for habitability of tenants and environment.

IPM Performance metrics:

Record keeping required by Department of Agriculture and when functioning, the PURS records system.

ODEQ

Model for IPM implementation:

DEQ doesn't implement IPM within in its own operations. However, ODA actively partners with the OSU on their intensive watershed-based IPM programs for agricultural producers in numerous watersheds.

This effort is an extension of the Pesticide Stewardship Partnership (PSPs) program that DEQ helped to establish in the early 2000's. DEQ's role in the PSPs and OSU's IPM program is to conduct water quality monitoring for pesticides, interpret the results of that monitoring and report on those results at IPM workshops and other forums.

Key goals:

Environmental protection, most notably the reduction of potential toxic chemicals and the improvement of water quality.

IPM Performance metrics:

DEQ measures pesticide concentrations in surface and ground water over time to determine the success of IPM and other pesticide Best Management Practice programs.

DOC

Model for IPM implementation:

DOC has standard health requirements and policies, which dictate the rules of confinement for inmates. House keeping and weekly sanitary inspections are examples of ways these standards are maintained. Monthly treatments for pests focusing on key problem areas also help maintain these standards.

Key goals:

Key goals include having a clean and sanitary environment within the living and working areas of the inmates and DOC staff, and preventing the spread of disease.

IPM Performance metrics:

DOC reviews all contracts on an annual basis. Any modifications that are necessary will be incorporated into the new contract. The safety managers are generally involved in the process.

Frequency of IPM program review

ODA

Eradication projects conducted by ODA are often funded by Federal partner agencies. If federal money is involved, an Environmental Impact Statement (EIS) or Environmental Assessment (EA) is completed to examine the environmental and human health risks. (See http://www.oregon.gov/ODA/PLANT/reports.shtml for an Environmental Assessment related to the Eugene gypsy moth project). An environmental assessment includes the following topics: Purpose and Need for Action, Public Involvement and Issues, Affected Environment, Alternatives, Environmental Consequences, Recommendation of the USDA APHIS and Oregon Department of Agriculture, and Conclusion.

Regular staff meetings provide an opportunity for ODA staff to employ the IPM decision-making process both when new exotic pests are accidentally introduced to the state, as well as for ongoing pest projects. As projects progress staff must continually reevaluate which tools are necessary for eradication, containment, control, or restoration objectives. In the early stages of an A-rated noxious weed eradication project, broadcast herbicide applications are often utilized to reduce large populations to levels that can either be spot treated by backpack applications or hand-pulled. Another common scenario involves the implementation of different methods based on parameters of sites spread across a larger landscape (multiple property owners: private, county, state, federal).

For example: Partners working to eradicate Alyssum, an A-rated weed spread across the Illinois Valley in southern Oregon, use hand-pulling exclusively on federal lands and along the Illinois River, implementing group volunteer pull events annually. Several of the most heavily infested fields were initially broadcast sprayed and through pest reductions achievements have been

transitioned to manual methods only. Repeated tillage has been implemented in some fields where growers preferred non-chemical methods. Each year, partners involved with an Alyssum Working Group, reevaluate which tools are best at each site across the landscape. The decision making process that is promoted through an engaged IPM process is the foundation of ODA pest projects.

A successful example is the Gypsy moth story: In the mid 1980's, the largest Gypsy moth infestation west of the Mississippi was found in Lane County. More than 19,000 Gypsy moths were caught in pheromone traps. Against the recommendation of the established Gypsy moth researchers, Oregon Department of Agriculture decided to apply a biological control agent to eradicate the Gypsy moth population that stretched over 250,000 acres. Over a period of four years with three aerial and ground treatments each year of the naturally occurring soil bacterium *Bacillus thuringiensis kurstaki*, (Btk), which is a natural enemy of butterfly and moth caterpillars, the Gypsy moth population was eradicated.

ODF

Although, as mentioned, the Department does not have a specific IPM program, relevant review processes, products and cycles include:

- *Forestry Program for Oregon* – overarching policy document revised every 8 years.
- Ongoing adaptive management checks (no specific cycle, done as need dictates and resources allow)
    - Forest Practices Act – Chemical & Other Petroleum Rules (Division 620) Implementation & Effectiveness Monitoring.
        - 2002 Forest Practices Monitoring Program Strategic Plan – Key Questions
        - Completed:

- Aerial Pesticide Application Monitoring Final Report, March 2000
- 2002 Best Management Practices Compliance Study

▪ Ongoing:

- Collaboration with Oregon Department of Environmental Quality (DEQ) Pesticide Stewardship Partnership – South Yamhill River.

In the State Forests Program, an annual review of operations and goals helps formulate the next year's annual operating plans. Review of IPM and other land management activities is part of that review and provides input for improvement through this regular business cycle.

ODF&W

Fish

Review is ongoing throughout the fish-rearing process through review of monthly and quarterly hatchery reports.

Rotenone projects are covered under a DEQ NPDES 2300A Pesticide General Permit and the associated Pesticide Discharge Management Plan. This permit is renewed and updated every 5 years. Projects to be implemented under this permit are reviewed and prioritized on a recurring basis.

Per EPA label requirements, all rotenone products are now required to follow all standards and procedures outlined in the American Fisheries Society's 2010 document *Planning and Standard Operating Procedures for the Use of Rotenone in Fish Management* - Rotenone SOP Manual.

Wildlife

Review of the IPM approach is ongoing. Treatment success is visually confirmed and treatments are re-applied as necessary.

ODOT

At the District level, IVM plans are reviewed and updated annually. The statewide IVM plan is reviewed and updated as changes are needed.

ODOT is currently in the process of a comprehensive review of its IPM program. Current topics include herbicide use, the IPM plan templates, and overall vegetation management practices.

DSL

Rangeland: Through annual EBIPM staff training as well as periodic program efficiency reviews.

Forestland: Annually, through the Oregon Department of Forestry (ODF) Annual Operation Plan process.

OPRD

The invasive species committee meets quarterly to evaluate the IPM, its implementation and effectiveness. The agency IPM and invasive species policy are reviewed and updated every five years. The invasive species committee, field managers and certified applicators provide input regarding IPM efficacy. Natural Resources staff employ ongoing review of species control methods and effectiveness.

DAS

DAS is a small IPM program with only 4 fully licensed pesticide applicators. All of them use the monitoring and threshold approach. We use many non-

chemical/mechanical approaches which are for the most part less expensive than chemicals for indoor pests. Once a year there is monitoring or tracking and review process for efficiency of the treatments.

ODEQ

DEQ reviews pesticide water quality data annually, and reports that data to agricultural producers and others who are engaged in IPM practices.

DOC

DOC reviews all contracts on an annual basis. Any modifications that are necessary will be incorporated into the new contract. The safety managers are generally involved in the process.

IPM Training for agency staff

ODA

Annually, ODA headquarters and field staff are invited to give IPM trainings, especially through the continuing education process for Pest Control Applicators. The Noxious Weed Control Program's Integrated Weed Control Specialists and some IPPM entomologists have Pesticide Applicator Licenses and like all licensed applicators are required to keep up with continuing education requirements. The ODA Weed Program organizes a three-day Interagency Noxious Weed Symposium every other year. On average, 200 Natural Resource Specialists from across the state attend to hear noxious and invasive weed updates, including the latest in IPM being conducted in Oregon. This biennial symposium offers applicator credits required to maintain a pesticide license in Oregon.

Insect pest control work, including helicopter applications of Btk is contracted out. ODA personnel design and oversee the applications. ODA is constantly looking for new and better ways of doing IPM. Oregon was the first state to successfully use Btk for gypsy moth eradication and ODA was essential in encouraging the manufacturer to develop an organic Btk formulation. ODA has also experimented with a detector dog for Japanese beetle grub detection and sterile insect release. Currently staff members are conducting experiments to find better lures for brown marmorated stink bug and spotted wing Drosophila. ODA is also one of the three leading agencies in the US involved in testing a biological control agent against the invasive brown marmorated stink bug.

ODA staff keep up with the latest developments in IPM through attending and presenting at professional society meetings/trainings such as: Interagency Noxious Weed Symposium, Oregon Vegetation Management Association, Entomological Society of America, Horticultural Inspectors Society, Annual Gypsy Moth Review, and National Plant Board. The Coordinated Weed

Management Area network is used to share information concerning the latest methods and approaches to IPM used to reduce risks posed by B-rated weed pests. Internal sharing and dissemination of information concerning program successes and knowledge gained in the implementation of IPM programs occurs throughout the year via email, forums, blog posts, and social media. Information exchange is also served through the State Weed Board and Oregon Invasive Species Council.

ODF

First, the ODF strives to hire professional foresters who have received broad-based college level or equivalent training. This includes IPM training.

Second, each employee has an annual performance evaluation that includes a discussion of training needs. A training plan is developed from this conversation and implemented during the following year.

Third, although training in general has suffered due to budget cuts, continuing education opportunities are available and encouraged, especially in the fields of silviculture, insect and disease management, forest health, and pesticide application. These opportunities include IPM.

Many but not all stewardship foresters and State Forests personnel attend workshops focused on pesticides in order to maintain pesticide applicator certification or general knowledge of their safe use.

The insect and disease staff specialists regularly attend state and national training sessions on current and emerging IPM issues.

Staff policy and technical support specialists attend yearly and/or regular workshops on regulatory, technical and environmental outcomes associated

with pesticide applications and vegetation management. Due to budget reductions, these staff have little or no capacity to provide on-request technical support or to conduct occasional training sessions for stewardship foresters and state and private forest landowners.

ODF&W

Fish

None except when using the piscicide (rotenone) applicators must be licensed and when possible attend the AFS Rotenone SOP training.

Wildlife

Many Wildlife Area staff receive training from ODA for a pesticide applicator's license, an ODFW trapping license or ODF prescribed burn safety training, as needed for their particular job requirements.

The Aquatic Invasive Species program staff receive Level I Watercraft Inspection training certified through the 100th Meridian ANS Task Force and Level II in-house decontamination training.

ODOT

Internally, ODOT provides IVM twice annually for pest management staff. Regional IVM trainings are held in the spring and a statewide IPM training is held in the fall. Topics of the trainings include noxious weed identification, biological control updates, herbicide safety, and vegetation management best practices. In 2014, over 100 ODOT employees and county weed management personnel attended ODOT IPM trainings. In addition, ODOT employees also attend external vegetation management trainings provided by Oregon State University, Chemeketa Community College, the Oregon Vegetation Management Association and others.

In addition, the ODOT statewide IVM Coordinator provides daily technical support to the maintenance districts including seeding recommendations, herbicide use recommendations, plant identification and policy interpretation.

DSL

Ecologically Based Invasive Pest Management annual training.

OPRD

The OPRD Invasive Species Committee and Natural Resource Section provide periodic internal invasive species awareness and management trainings to regional staff. All OPRD pesticide applicators are required to be licensed by ODA and must complete continuing education trainings to maintain their licenses. Internal invasive species training is usually coordinated with ODA to provide continuing education credits to licensed applicators.

DAS

Department of Agriculture accredited pesticide training classes required by law to maintain licenses. Also networking with our staff of 5 applicators on the successes and failures and experimentation.

ODEQ

None cited.

DOC

Historically, the safety managers have been the primary point of contact for the pest management function. Training of general staff has never been required.

Case Studies

A focus on the ODA

Purple loosestrife

Introduction

Purple loosestrife, *Lythrum salicaria* Lythraceae, is an exotic invasive plant from Eurasia that infests wetlands and riparian zones in North America. After its arrival in the early 1800s, and without natural enemies to keep it in check, it has since spread across much of the middle and northern latitudes of the U.S. (Thompson et al. 1987, Mullin 1999, Piper et al. 2004). The plant reproduces by seed and fragmentation of plants, allowing infestations to proliferate and spread.

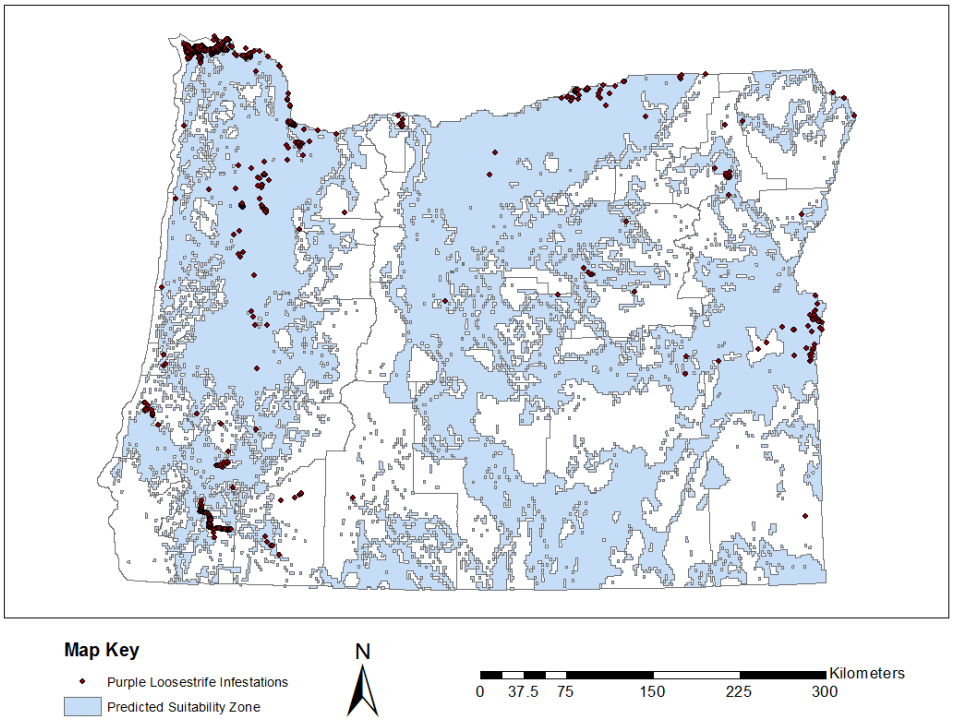
Identification

Purple loosestrife is a semi-woody herbaceous plant with long showy spikes made of showy purple flowers consisting of 5-6 petals. The seeds are very small, and large plants can produce over one million seeds. Stems are four to six sided and leaves are lance-shaped with smooth margins. Plants can be 3-10 feet tall, and have a single flowering spike or many, depending on age and habitat.


Purple loosestrife flower (L) and infestation at Horseshoe Lake, Marion County (R).

Current Status & Distribution

Purple loosestrife is widely established in Oregon, occurring along rivers, streams, ponds, marshes, wetlands, seeps and wet meadows. Sites where the native wetland vegetation have been disturbed and created wetlands lacking natural wetland flora are particularly vulnerable to loosestrife infestation.



Known infestations of purple loosestrife (dots) and predicted vulnerable areas (shaded) based on known habitat features and requirements (Weedmapper 2013).

Control and Management Options

Because purple loosestrife inhabits wetlands and riparian zones, control options are often limited because of the sensitive nature of the infested habitats. Intensive management of purple loosestrife can be a difficult problem, in that water quality can be severely impacted, threatening ecosystem function and services. For small infestations (<0.1A), manual control may be sufficient. Some chemical control has been implemented using a limited number of approved aquatic herbicides can be sporadically effective, but reinfestation from seeds is often the result, along with loss of susceptible plant species. For most sites more than 0.25A, biological control (the use of four beetles which are host specific natural enemies) has been the priority control measure in Oregon since 1992. Successful control of purple loosestrife was manifested as early as 1997 at multiple sites in eastern and western

Oregon, especially in areas that have less than one foot of standing water during the flood season. Purple loosestrife in tidally influenced rivers and marshes (i.e. lower Columbia and Umpqua rivers and Coos Bay tidal marshlands), and in streams that experience high intensity and short duration flooding in the spring (Rogue and Umpqua rivers and selected tributaries) are not as suitable for biological control.

Economics

The primary economic impacts (estimated at $1.48 – 4.29 M/year (Radtke 2000)) of purple loosestrife occur from lost opportunity costs when infestations interfere with ecosystem products and services (i.e. water quality, hunting, fishing, species diversity of wetlands, etc.). Purple loosestrife has a low ecological amplitude when compared to its potential distribution in Oregon. Once entrenched, purple loosestrife can form thick stands that exclude desirable flora and its important associated fauna (Schooler et al. 2009). Loosestrife infestations can also negatively impact the cycling of nutrients in aquatic systems (Schooler et al. 2006). The implementation of biological control may well prevent purple loosestrife from ever achieving its full biological potential in Oregon, saving millions of dollars in ecological and socioeconomic impacts and improving water quality in the state.

Conclusion

Purple loosestrife is a difficult weed to control by nature of the unique and vulnerable habitats in which it occurs in Oregon. Small infestations are best handled with intensive control measures like manual and chemical control. Once infestations are too large for intensive control measures, biological control is the best option, achieving 50-95% control ability at inland sites. Coastal sites in tidal zones are especially difficult, and experiments are continuing to develop nursery sites in the upper elevational zones to maintain colonies of biocontrol agents.

Literature Cited

Mullin, B. 1999. Purple loosestrife. In: Sheley, R.L. and J.K. Petroff (eds.). Biology and management of noxious rangeland weeds. Oregon State University Press. Pp. 298-307.

Piper, G.L., E.M. Coombs, B. Blossey, P.B. McEvoy and S.S. Schooler. 2004. Purple loosestrife. Pages 281-292 *in* E.M. Coombs, J.K. Clark, G.L. Piper, and A.F. Cofrancesco, (eds.). Biological Control of Invasive Plants in the United States. Oregon State University Press, Corvallis, OR.

Radtke, H. 2000. Economic analysis of containment programs, damages, and production losses from noxious weeds. Report to: Oregon Department of Agriculture, Salem. 40p. plus Appendices.

Schooler, S.S., P. B. McEvoy, and E. M. Coombs. 2006. Negative per capita effect of purple loosestrife and reed canary grass on plant diversity of wetland communities. Diversity and Distributions, 12: 351-363.

Schooler, S.S., P.B. McEvoy, P. Hammond, and E.M. Coombs. 2009. Negative *per capita* effects of two invasive plants, *Lythrum salicaria* and *Phalaris arundinacaea*, on moth diversity of wetland communities. Bulletin of Entomological Research. 99: 229-243.

Thompson, L.Q., R.L. Stuckey, and E.B. Thompson. 1987. Spread impact and control of purple loosestrife *Lythrum salicaria* in North American wetlands. U.S. Fish and Wildlife Service. Fish and Wildlife Research 2.

Weedmapper. 2013. Oregon Department of Agriculture, Salem. http://www.oregon.gov/ODA/PLANT/WEEDS/WEEDMAPPER/Pages/index.aspx

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Insect Control Programs

IPM in Action: Gypsy Moth, Japanese Beetle, and Insect Biocontrol

The ODA Insect Pest Prevention and Management program follow IPM principles by adhering to the following steps:

1. Pest prevention by quarantine, inspection, and public education.
    - Both Gypsy moth and Japanese beetle are federally quarantined pests. Additionally ODA established Japanese beetle quarantine in Oregon. We follow all quarantine rules to prevent the pests from being imported into Oregon.
    - Each summer during Japanese beetle flight season, ODA inspect cargo airplanes from eastern infected states such as UPS planes from Louisville, KY and FedEx planes from Indianapolis, IN to prevent any hitchhiking beetles from accidentally being imported into Oregon. In 2014, ODA inspected 41 cargo planes.
    - We also give presentations at growers meetings, master gardener clubs, pesticide certification classes etc. to educate the public about our programs.
2. Early detection using pheromone traps and establishing eradication treatment thresholds.
    - ODA deploys pheromone traps to detect gypsy moth and Japanese beetle during the summer months when adults fly. Traps are placed throughout the state with high densities concentrated around high-risk areas. In 2014, ODA deployed 11,985 gypsy and Asian gypsy moth traps and 2,543 Japanese beetle traps. At sites where these insect pests were detected last year, ODA deployed high-density traps to delimit the area and confirm if breeding population were present. If confirmed, an eradication treatment threshold is reached and eradication treatments are considered for the following year.
3. Correct identification of insect pests through traditional, molecular, and/or other advanced techniques.

- ODA entomologists first identified all positive catches from traps. Next all suspected gypsy moth catches are sent to a USDA lab for molecular identification to confirm if the moth is the gypsy moth or Asian gypsy moth. In 2014, four gypsy moths were trapped in the Grants Pass area. The USDA confirmed all four moths as North American gypsy moths. ODA also sent Japanese beetle catches to North Arizona University to determine the state or region of origin using isotope analysis.

4. Integration of climate factors to determine optimal eradication treatment timing.
   - For the gypsy moth eradication project we often use local weather data and climate modeling to predict optimal time for treatment. For Japanese beetle ODA relies on historical phenologic data to determine best treatment timing.
5. Selection of best management options, which include: cultural or ecological control, technological and bio-technological control, microbiological control, ethological control, biological control, genetic control, and chemical control. Toxicity, mode of action, residual effect, non-target effect, and cost are all evaluated when chemical control is considered.

   - For gypsy moth eradication projects ODA often uses a microbial insecticide, Btk which can come in different formulations, including one approved for organic farming. ODA also uses mating disruption through sterile male techniques. Mass trapping has been tried as well. These methods reduce the use of pesticides. Since eradication treatment thresholds were not reached, treatment was not necessary in 2014.
   - For Japanese beetle eradication projects ODA often uses an Acelepryn insecticide, Anthranilic Diamide, a new class of chemistry. This class of pesticide has very low toxicity to non-targets including mammals and other arthropods. A granular formulation of Acelepryn is applied to turf and landscape beds to target the grub stage of Japanese beetle. ODA project areas in 2014 included: Portland

International Airport in Multnomah County. Granular applications in May of 2014 included four sites totaling 175 gross acres. The application rate was 2.3 lbs/1000 sq ft or 100 lbs/acre. ODA also targeted Japanese beetle adults through treatments to trees, shrubs, and turf at two sites at the Portland International Airport in July and early August 2014. The pesticide used was Tempo SC Ultra, which was applied by truck mounted sprayers. About 101 gross acres in Multnomah County were treated at the rate of 5.4 oz./100 gallon water for foliar sprays and 12 oz./acre or 6.9oz./100 gallon water for turf treatments.

Insect Pest Biological Control Program

The ODA Insect Pest Prevention and Management program also has a couple of ongoing insect biological control projects. These projects involve the use of natural enemies such as parasitoids. When biological control is successful pesticide applications can be completely eliminated.

- Insect biological control program: cereal leaf beetle
  Cereal leaf beetle was first detected in Oregon in 1999. As of 2014, ODA has redistributed and established the larval parasitoid *Tetrastichus julis* in most part of the state where cereal leaf beetle is established. As a result, most growers do not have to spray for this pest anymore. ODA won three awards (from USDA, OSU, and Entomological Society of America) for the success of this program. In 2014, ODA collaborated with the USDA to do a field-training in Klamath County to train OSU extension personnel, staff from the California Department of Food and Agriculture, as well as staff from several northern California counties. The training focused on techniques in the collection, dissection, and release of biocontrol materials.

- Insect biological control program: brown marmorated stinkbug
  ODA is in the process of determining if the parasitoid, *Trissolcus japonicus* is a good biological control candidate. ODA has been testing the parasitoid at OSU's quarantine facility against the brown marmorated stinkbug, as well as non-target stinkbugs from Oregon. ODA just completed it's third year of testing and is hopeful that a parasitoid may be released within next couple of years. This project is funded by USDA and involves the collaboration of several state agency, university, and USDA labs.

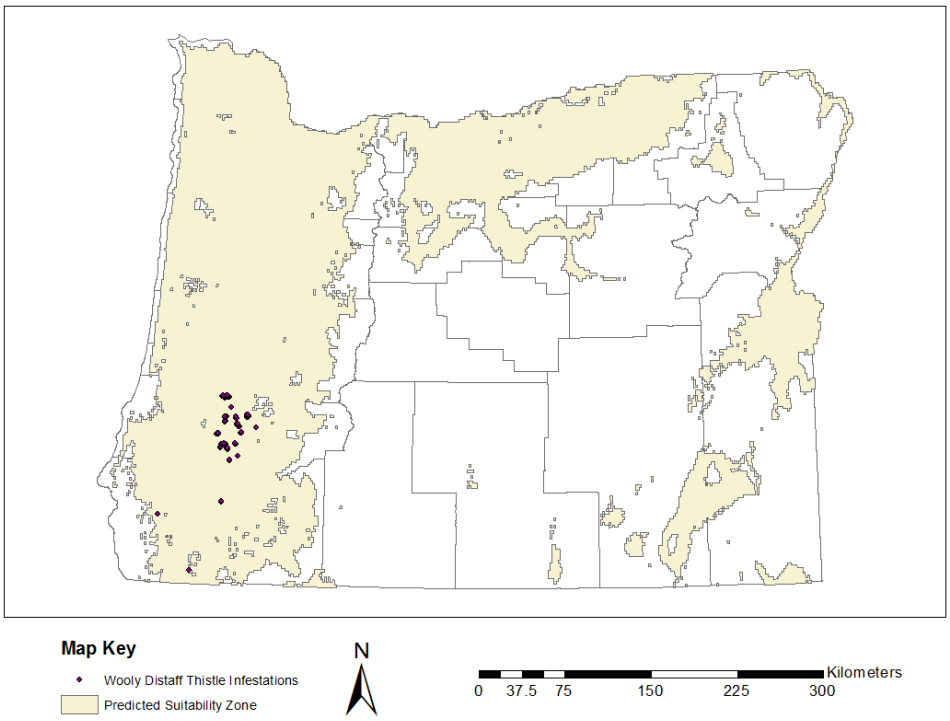
Woolly distaff thistle

Introduction

Woolly distaff thistle, *Carthamus lanatus*, is a federally listed noxious weed and is considered one of the worst pasture weeds in North America and Australia (Burrill, 1994). It is a highly adaptable member of the aster family, heavily armed with spines and produces an abundance of long-lived seeds. In dense infestations, it imposes significant impediments to forage production and quality meanwhile creating physical barriers to grazing access (Burrill, 1992). First reported in California in 1891, it has since become widespread in that region where it infests thousands of acres of seasonally dry hillside pasture (DiTomaso, 2013). In Oregon, the first infestation was identified in 1987, with infestations now occurring in three counties in southwest Oregon.

Current Status & Distribution

Distaff thistle infests acreage across 40 ownerships in 21 locations in Oregon. Eighteen of these locations are in Douglas County, two in the northern reaches of Josephine County, and one in Curry County. Woolly distaff thistle has been reduced by 97% from historic levels, from 123 net acres to less than 3.5. Since 2009, the population has fluctuated between 2.5 and 3.5 net acres. No new sites have been discovered since 2006; helicopter surveys are conducted periodically to rule out potential detection gaps.



Known infestations of Woolly Distaff Thistle (dots) and predicted vulnerable areas (shaded) based on known habitat features and requirements (Weedmapper 2013).

Control and Management Options

Elimination of seed production and seeds banked in the soil are key when battling an annual thistle. Early season applications with a selective herbicide or manual methods before flowering are effective in controlling distaff thistle (Peachey et. al). Mowing can be effective under dry soil conditions if done just prior to flowering. Mowing in wetter soils is only minimally effective as plants re-grow and flower. Distaff thistle is easier to control when immature, however individual plants are often hard to see until the surrounding forage starts to dry.

Intense grazing management can be effective under certain conditions. Healthy grass stands make areas less susceptible to invasion. Woolly distaff thistle is so closely related to safflower that it is often confused with the commercially produced plant when located in a field (Abrams and Ferris, 1961). The genetic similarities between the two species are so great that biological control has not been pursued in the United States.

Economics

Wooly distaff thistle can drastically decrease forage availability for wildlife and grazing animals where heavy infestations occur (Burrill, L.C. 1994; DiTomaso 2006). Mature dead plants stay rigid and spiny after they mature and senesce, rendering vast acreage unusable and more prone to catastrophic wildfire (Grace 2002; Sindel, 1991). In Australia woolly distaff thistle reduces cereal grain yields, clogs harvesting equipment, and increases seed cleaning costs (Fromm, 1990). Distaff thistle spines are also known to result in contamination and downgrading of wool (Grace, 2002).

Woolly distaff thistle's devastating impact to rangelands in Australia (left) and

California (right)

Photos by Dennis Isaacson (left) and Joseph M. DiTomaso, UCCE (right)

Conclusion

Biologically distaff thistle represents the perfect case study of why a sustained, statewide weed eradication campaign is necessary. Distaff thistle, like yellow starthistle, is a classic long-lived winter annual. It germinates early and develops a long taproot that can draw water from deep in the soil profile, allowing flowering and seed-set after annual grasses have become dormant (Burrill, 1994). Seeds can lay dormant in the soil until conditions are ideal for seedling survival resulting in a slow distribution over time (Grace et. al., 2002). To complicate matters, distaff thistles is not exceptionally showy and new populations may establish and expand for years before they are located. Lastly, unmanaged distaff populations in California present a consent reintroduction threat to Oregon. In the late 1980s the ODA Weed Program made a calculated decision to protect Oregon from invasion by yet another aggressive thistle. The success of this longstanding eradication effort is undeniable, less than four net acres infested in the entire state.

Literature Cited

Abrams, L. and Ferris, R. S. 1961. Illustrated flora of the Pacific states. Stanford: Stanford University Press. Briese, D. T. 1988. Weed status of twelve thistle species in New South Wales. Plant Protection Quarterly 3:135-141

Burrill, L. C. 1992. Distaff thistle, *Carthamus lanatus*. Pacific Northwest Extension Bulletin 420. Washington State University Extension.

Burrill, L.C. 1994. Distaff thistle (*Carthamus lanatus*), A "Weeds" Pacific Northwest Extension Publication. PNW 420, reprinted May 1994.

DiTomaso, J. M. (2004). 2004 Cal-IPC Red Alert! New invasions, recent expansions, and a few others to be on the lookout for. California Invasive Plant Council Symposium 2004. Ventura, CA.

DiTomaso, J. M. and E. A. Healy. 2006. Weeds of California and Other Western States. University of California Department of Agriculture and Natural Resources.

Fromm, G. M. 1990. Chemical control of saffron thistle (Carthamus lanatus L.) in pasture in the South Australian Mallee. Plant Protection Quarterly 5:14-17.

Grace, B. S. et. al. 2002. Seedbanks and seedling emergence of saffron thistle (Carthamus lanatus) in eastern Australian pastures. Australian Journal of Agricultural Research 53 (12), pp. 1327-1334.

Oregon Department of Agriculture, Plant Division, Weed Program. 2010. Personal Communication with staff members: Ken French and Eric Coombs, Natural Resource and Biological Control Specialists, respectively.

Peachey, E., D. Ball, A. Hulting, T. Miller, and D. Morish. The Pacific Northwest Control Handbook. A Pacific Northwest Extension Publication. Weed Control in Range and Pastureland Section Revised December 14, 2009 by T. Miller.

Sindel, B. M. 1991. A review of the ecology and control of thistles in Australia. Weed Research 31:189-201.

Weedmapper. 2013. Oregon Department of Agriculture, Salem. http://www.oregon.gov/ODA/PLANT/WEEDS/WEEDMAPPER/Pages/index.aspx