



MINISTRY OF ENVIRONMENT
AND TOURISM



RAPID ASSESSMENT OF FOREST PROTECTION ACTIVITIES MONGOLIA

UN-REDD Mongolia National Programme

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UN-REDD
PROGRAMME



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APPRECIATION:

I appreciate the hospitality and cooperative effort of Mongolia's Ministry of Environment, Forest Research Development Center, diverse Research Institutions and Universities, UN-REDD and Forest Pest Control companies to introduce me to the pest situation, forest conditions, and research and insect control efforts that are underway in Mongolia.

Chris Dickinson, UN-REDD Mongolia, worked effectively with the USDA Forest Service International Programs unit to establish clear objectives for this cooperative assessment and to increase communication for continuing opportunities. I appreciate the opportunity to serve.

Jagdag D., Department of Forest Policy & Coordination, was generous with his time and attention to provide excellent briefing on the current situation, FRDC actions, and pest control issues facing Mongolia. He traveled to Terelj National Park, Arkhangai and Selenge provinces to view and discuss pest outbreaks and management practices.

Ganzorig Batkhishig, Head of the Forest Protection, Restoration and Silviculture Department, Forest Research Development Center, also took time away busy field operations to participate in the travel and discussions, and share his insights about the pest situation, monitoring and control activities.

Bilguun.O, REDD+ Governance Activity Coordinator, organized the field travel and assisted with translation and logistical supervision. He provided additional orientation to Mongolian culture and ensured my curiosity could be satisfied. He helped organize the Workshop in Ulaanbaatar and facilitated travel and communication support.

Davaadorj Enkhnsasan, Research Entomologist, Institute of Biology provided a thorough introduction to their facilities and joined the field travel, collecting and observing insect monitoring processes, and eager to identify potential additional biological control agents.

Batchudur Bat-Amgalan, Research Entomologist, Institute of Geography and Geoecology, was particularly helpful as a skilled taxonomist (author of Common Insects of Mongolia) with compassion to the forest ecosystem and appreciation for multiple uses of forest resources.

Balgamar Tuulairchuu, Senior Lecturer, Mongolian University of Life Sciences, was an excellent translator and interpreter and joyful companion. She was perceptive to my comfort and level of understanding, and was instrumental to my ability to perceive the situation and describe my reactions and ideas.

Batmunkh Purvee, Driver, United Nations Development Programme, was highly skilled, well-equipped and committed to our group's safe, comfortable travel across the long distances of Mongolia's broad landscape.

I am deeply impressed by the dedication and high quality work of these organizations and individuals. I am also impressed by the degree of challenge they face by great distances, difficult access, a severe climate, virulent pests, and undeveloped forest management infrastructure.

I hope my experience and sincere observations can help Mongolian academic and professional organizations identify opportunities for improving forest protection activities. Sincerely, Karen Ripley



Photos, from left to right: Dendrolimus sibiricus larva; Sampling Dendrolimus sibiricus using a beating cloth; Jacobsen's spanworm larva; air tractor spray application plane.

RAPID ASSESSMENT OF FOREST PROTECTION ACTIVITIES MONGOLIA

Karen Ripley, Forest Entomologist, USDA Forest Service

At the invitation of UN-REDD, Karen Ripley, Forest Entomologist with the USDA Forest Service came to Mongolia in June, 2017 to review and assess opportunities for improved forest protection strategies with respect to monitoring and controlling forest insect pests.

A series of briefings, research presentations and field trips to the UB Green Zone, Terelj National Park, and Arkhangai, Bulgan, and Selenge Provinces were organized to inform and provide opportunities for her to observe, investigate and discuss pest effects and forest protection activities. Conversation was rich on long vehicle rides and at shared camp sites. Information on “Asian Gypsy Moth Eradication Activities in Oregon and Washington 2016” was presented to Mongolian aerial pesticide applicators in Bulgan province.

A formal workshop, with Ripley sharing “North American Philosophy and Methods for Pest Control” and her “Ideas for Improved Forest Protection Activities in Mongolia,” with discussion following, occurred June 15, 2017 in Ulaanbaatar. It was well attended, English presentations were translated and interpreted in Mongolian, and the resulting discussion was active.

This report summarizes Ripley’s observations and recommendations.

Background

The boreal forests of Mongolia cover approximately 13 million hectares (FRDC, 2015; ‘forest taxation inventory’). They are dominated by Siberian larch (*Larix sibiricus*), with significant components of Siberian pine (*Pinus sibiricus*), Scots pine (*Pinus sylvestris*), birch (*Betula* spp) and poplar (*Populus* spp). Major forest pests include the Siberian silk moth (*Dendrolimus sibiricus*; family Lasiocampidae), Jacobsen’s spanworm (*Erannis jacobsoni*; family Geometridae), Asian gypsy moth (*Lymantria dispar*; family Lymantriidae), and rusty tussock moth (*Orgyia antiqua*, family Lymantriidae). Secondary bark and wood-boring insects such as *Ips*, *Scolytus*, Buprestid and Cerambycid beetles can kill trees weakened by defoliation.

Mongolia has a tradition of insect research dating back to the beginning of the 19th century and an academic forest insect research program established at the National University of Mongolia in 1942. Many Research Institutes currently pursue basic and applied research on forests, forest insects and the environment that is relevant to forest protection strategies and methods. There is rich local expertise available to address and focus on timely questions.

Mongolia’s Department of Forest Policy and Coordination (FRDC) annually conducts distribution surveys of forest pests over about 2 million hectares of boreal forest and provides pest control operations on about 110 thousand (average from 2006 to 2014) to 150 thousand hectares. Their objectives are to reduce pest populations, reduce the use of forest pest control chemicals (ceased by the federal agency in 2010), increase use of control measures that have less environmental impact (biological pesticides, pheromone trapping, light trapping, mechanical suppression, and increasing the influence of parasites and predators

of the pests), and reduce future pest outbreaks and infestations. They have a strong network of surveyors and seem to communicate effectively about the locations of current insect activity.

Several provinces independently conduct pest control operations, often choosing chemical methods because of low cost and rapid insect killing.

General Observations and Recommendations:

The goal of modern forest health protection is to manage the trees and forests to become more resistant or resilient to damage from native pests and the environment. Forest managers recognize that the amount of tree damage that will occur depends on a combination of the vigor of the host trees, the size and virulence of the specific pest population, and the physical (weather, nutrients, topography) and biological (predators, parasites present) environment (Figure 1). The most durable, efficient ways to improve forest health integrate management of all three factors to minimize damage: strengthen the trees, moderate the environment, and weaken the pest insects. Most forest managers also have to make choices about where they choose to spend scarce worker effort and investment dollars. The objective for the forest area influences the tolerance for pest activity and whether prevention or response will even be used.

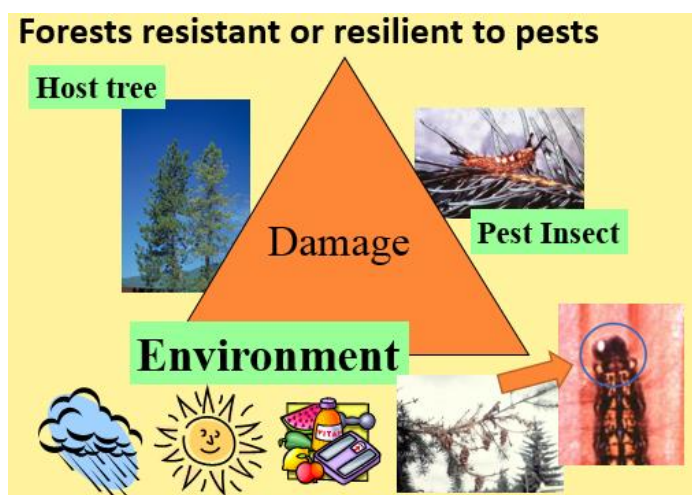


Figure 1: The amount of damage that occurs is related to the host, pest and environment, so strategies to increase forest resilience and resistance to pests must consider all these factors. Also, if the forest objective (timber, recreation, wildlife habitat) is not threatened by the pest activity, it is a low priority to conduct pest prevention or control treatments.

Insect outbreaks tend to increase and decline in four phases (“Release”, “Peak”, “Decline” and “Postdecline”) (Figure 2). It’s important to identify and thoroughly understand the *unique* pattern and contributing factors that affect each insect pest and forest type, such as the specific factors that trigger the release and rapid growth of insect populations, the outbreak threshold (insect numbers that indicate an outbreak has initiated), the typical duration of an outbreak, and the factors that contribute to the outbreak decline. This information informs pest control decisions. It is particularly important that pest control activities:

- a) be applied early in an outbreak, as soon as the “Outbreak Threshold” is reached, to avert the “Release” from continuing,
- b) be avoided after the “Decline” has initiated because the outbreak will subside without human effort and expense, and
- c) do not interfere with the natural factors such as beneficial predators and parasites that are causing the “Decline”.

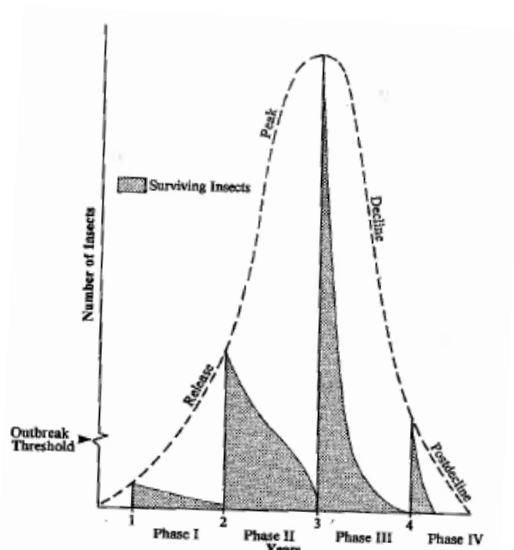


Figure 2: Insect outbreak cycles have 4 phases: Release, Peak, Decline, Postdecline. (Source: *The Douglas-fir Tussock Moth: A Synthesis*.) In Douglas-fir tussock moth (*Orygia pseudotsuga*) each of the first 3 phases each last about one year and there will be at least a seven year Postdecline period between outbreaks. The specific pattern depends on the insect species and forest type. The same insect species can have populations that follow different outbreak patterns at different elevations or in different forest types.

Similar to the philosophy prevalent in North America, Mongolian forest protection efforts attempt to use detailed knowledge and monitoring of the forest condition (trees, insects and environment) to implement precise, durable actions that avoid unintended consequences.

FRDC staff are hardworking and knowledgeable about forest insect detection and assessment methods. They were generous with their time and worked with UN-REDD staff to plan efficient, logical briefings and field visits to share information about forest conditions and protection activities. FRDC staff attempt to identify insect outbreaks as quickly as possible; often relying on visible defoliation to indicate outbreaks. Unfortunately, this may be later than a theoretical “Outbreak Threshold” and the population may already be large and already inflicting serious damage when control efforts are applied.

Although FRDC has established “thresholds” intending to only apply insect control efforts to high insect populations, control often occurs late in an outbreak when damage has already occurred and when beneficial predators and parasites are exerting some control. The Forest Protection program could benefit from:

1. Additional insect outbreak “early warning” information that focuses closest attention on the forests that are the most likely to be significant insect hotspots and whose management objectives (timber, view, human health) are most vulnerable to unacceptable damage.
2. Refinement of established pest control standards to more effectively apply control early in an outbreak cycle when it will effectively prevent full “Release” of insect populations.
3. Increase quality control evaluations such as monitoring spray deposition and untreated reference plots to ensure that the pesticide applications that occur are delivering the pesticides in a manner (timing, coverage, droplet size, biologically active) that will be effective.
4. Continue to focus specific control techniques on the life stages of the insects that are available and vulnerable.
5. Avoid general insecticide treatments when the outbreaks are already in “Decline”.

The limitation of federal use of non-selective chemical pesticides is good policy. It supports many integrated objectives such as avoiding environmental damage, protecting beneficial insects, and improving the research and business infrastructure necessary to develop additional biological pest control techniques.

General suggestions for improvement are summarized in 5 categories:

1. **Silviculture knowledge and application.** Compile, increase and apply information that is specific to the forest trees and growing situations in Mongolia in order manage forests to effectively improve tree health. This will involve increasing tree and forest resilience and resistance to forest insect activity, preventing damage or enabling rapid recovery from disturbances, and describing and pursuing specific forest management objectives.
2. **Insect detection and early warning.** Continue to improve early detection systems and the ability to understand specific factors that trigger and influence the duration and intensity of local forest insect disturbances.
3. **Insect control.** Use knowledge of insect outbreak phases, physical and biological influences, and likely impacts to management objectives to prioritize and implement direct insect control. Continue commitment to non-chemical pest control methods. Increase reference plot monitoring and quality control evaluation of pest control activities in order to improve the effectiveness of current and future activities.
4. **Research.** Research Institutes should assist FRDC to develop and implement rigorous quality control monitoring procedures for evaluating forest pest control efforts (#3). Investigate and develop new direct control technologies such as Nucleo Polyhedrosis Viruses. Increase knowledge and awareness of Mongolia’s forest ecosystems and pest outbreak dynamics in order to consider and employ biological influences such as tree vigor, and beneficial parasites and predators. Share knowledge and information broadly.
5. **Public information and forest stewardship.** Share and broaden forest ecosystem management knowledge and protection concepts, with a pride in forest stewardship, across diverse professional segments and the public.

Additional detail on suggestions for improvement are listed below. Items that can likely be initiated or improved or implemented immediately are indicated with “immediate”. Suggestions that can be implemented within 6 months to a year are indicated with “soon”.

1. Silviculture Knowledge and Application:

1. Consolidate, share and **improve knowledge of Siberian larch (*Larix sibirica*) silviculture**, management strategies and growth potential. (immediate)
 - For all Mongolian boreal forest tree species, compile and publish information such as in “Silvics of North America, USDA Forest Service, Agriculture Handbook 654. Volume 1- Conifers” and “Volume 2-Hardwoods”. (soon) (https://www.na.fs.fed.us/spfo/pubs/silvics_manual/table_of_contents.htm). Note: This book already includes a section for *Pinus sylvestris* growing in North America, but the details of its natural history may be different in Mongolia. The goal of this recommendation is to compile information that is relevant to the forestry profession in Mongolia. (soon)
 - Improve regeneration methods (nursery techniques, site preparation, planting techniques, site monitoring and maintenance) to ensure forests are well-stocked with vigorously growing trees.
 - Obtain or develop growth information for *Larix sibirica* on various site classifications (elevation, aspect, soil characteristics, precipitation, site indicator understory plants) and tree densities. Although growth information is likely available from FAO, Russia or Eastern Europe, it may need to be adapted for unique Mongolian site characteristics.
 - Implement forest management techniques that protect tree health and ensure trees are able to adequately grow in diameter.
2. **Establish specific management objectives for individual forest compartments, units** and areas to identify land usage, goals for tree growth and form, and tolerance for insect activity.
 - Describe priorities for specific land units based on legal classification (protected areas, national park, general forest) and priority management objective (forest product production; water quantity and quality management; wildlife protection; non-timber forest production; scenic quality and recreation; etc.). Land units will provide multiple benefits, but identifying the most important, priority use clearly determines management strategies and tolerance for disturbances. Also identify areas that are low priority or will not be eligible for control of native forest defoliators.
 - Nearly every major forestry research university in the USA and Canada has ownership or long term control of a specific forest area to conduct research and experimentation (See University of Washington “Charles Lathrop Pack Forest,” 4,300 acres; Oregon State University and USDA Forest Service “H.J. Andrews Experimental Forest,” 16,000 acres; University of British Columbia “Alex Fraser Research Forest,” 10,000 hectares and “Malcolm Knapp Research Forest,” 5,157 hectares). Commit specific land areas to individual or groups of Universities and Research Institutes as “Experimental Forests” or “Demonstration Forests”. Provide sufficient land for adequate replication of field experiments (but additional replicates should also occur in the general forest). Study such North American Universities’ research forests to develop appropriately representative administrative boards, written charters and by-laws, and dedicated budgets to ensure high quality priority projects are implemented and the long term integrity and utility of these Mongolian research and demonstration forests is maintained.
3. **Manage larch forests to improve tree vigor, resistance and resilience.**
 - Increase proportion of provincial forest income revenue share that is committed to silvicultural activities like thinning for forest improvement.

- Apply information from 1.1. to identify actions and management schedules for specific forest compartments and watersheds. Implement those plans and monitor results to ensure expectations are sound and objectives are being met. Use informed adaptive management strategies to achieve objectives. Soon.
 - Identify areas to **diversify larch forests with additional native species** such as *P. sylvestris* and *P. sibiricus*.
 - Develop action “roadmap” with targets for forest management accomplishments – by province, by year. It may be more useful to initially focus on action areas that already have timber production infrastructure, rather than trying to accomplish forest improvement everywhere.
4. Develop efficient practices to **regenerate dead forests** into productive, resilient forests. This involves more than the dead trees disappearing. It involves making focused salvaged efforts that will produce revenue or agreement for labor to steward the site, plant seedlings or monitor natural regeneration, and accomplish a stocking (species, tree number, tree quality, free-to-grow) prescription.
5. Identify and **steward legacy structures** that sustain ecosystem function. “Legacy structures” are physical and biological features that make significant contributions to ecosystem function and are difficult to restore or require a long time to regrow, such as springs, wet meadows, large old trees, large dead standing trees, large fallen logs, and wildlife nesting sites.
- Identify important legacy features of different Mongolian forest types. Not every hectare or compartment will provide every legacy feature.
 - Locate and document critical legacy features currently present on individual sites. Some information about these structures may be kept with minimal publicity in order to protect them. Some information about these structures may be widely publicized for education, generating local pride and stewardship, and ecotourism potential.
 - Create and enforce protection standards for legacy features.
 - Plan for replacement of legacy features as they decompose or degrade over time.
6. **Protect and enhance beneficial predators and parasites** and their habitats during forest management activities.
- Continue to use the most environmentally friendly, selective pesticides to achieve objectives. (immediate)
 - Avoid direct control of pests, especially using non-selective chemical control methods, in the declining stages of outbreaks. (immediate)
 - Preserve and release beneficial insects gathered during egg mass collection. (soon)
 - Evaluate non-target effects of light trapping operations.
 - Protect some wildlife trees and logs on every hectare.

2. Insect Detection and Early Warning:

1. **Identify the physical and biological conditions that trigger defoliator outbreak cycles.** Develop detection survey protocols (local reporting, pheromone or light traps, egg mass or cocoon surveys) to provide early warning before defoliation is visually apparent or when defoliation is very confined. Develop the professional forestry workforce capacity and delimitation procedures for investigating early signals of new outbreaks.

2. **Identify factors (stand, tree, insect, physical environment, biological environment) that influence the size, duration and intensity of defoliator outbreaks** to enable efficient, appropriate prevention and intervention. (soon)
 - a. Inform 1.3 in order to develop forestry prescriptions that will alter vulnerable stand, tree and biological conditions to increase tree vigor and resilience and prevent tree damage. (soon)
3. **Quantify the impacts of insect populations and defoliation intensity** to host trees of various growing conditions.
 - a. Inform 1.3 in order to develop forestry prescriptions that alter vulnerable stand, tree and biological conditions.
4. **Add detail to the '100 insects/tree' standard for pest control.** It is a good initial threshold, but can be refined by insect species, outbreak phase, and forest type.
5. Make use of **effective communication** channels to efficiently share information about pest observations, outbreak status, and natural events that reduce or increase insect populations.
 - a. Improve communication and shared language for the concept of "Golomt".
6. Enable **rapid utilization of killed trees** to preserve wood quality and manage secondary pest populations.
7. References for integrated management and technical transfer about relevant forest pests.
 - a. Brookes, M.H., R.W. Stark, and R.W. Campbell, eds. 1978. The Douglas-fir tussock moth: A synthesis. USDA For. Serv. Tech. Bull. 1585. 331 pages. <https://ideas.repec.org/p/ags/uerstb/158054.html>
 - b. Maclauchlan, Lorraine. Douglas-fir Tussock Moth Management Strategy Southern Interior Forest Health Program. Describes short- and long-term management strategies for Douglas-fir tussock moth. The short term strategy decisions are based on the forest ownership and on the year of the outbreak cycle. https://www.for.gov.bc.ca/rsi/ForestHealth/PDF/DFTM_Strategy_Feb_2013.pdf
 - c. Brookes, M.H., R.W. Campbell, J.J. Colbert, R.G. Mitchell, and R.W. Stark, Technical Coordinators. Western Spruce Budworm. USDA Forest Service Technical Bulletin 1694. 1987. 198 pages. <http://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=1318&context=barkbeetles>
 - d. Brookes, M.H., J.J. Colbert, R.G. Mitchell, and R.W. Stark, Technical Coordinators. Managing Trees and Stands Susceptible to Western Spruce Budworm. USDA Forest Service Technical Bulletin 1695. 1985. 111 pages.
 - e. Wallner, W.E. Factors Affecting Insect Population Dynamics: Differences Between Outbreak and Non-Outbreak Species. Annual Review of Entomology. Vol. 32:317-340. January 1987. <http://www.annualreviews.org/doi/pdf/10.1146/annurev.en.32.010187.001533>

3. Insect Control:

1. Use effective insect control strategies that **reduce pests but avoid environmental damage**.
 - a. Maintain commitment to use of selective, biological pest control products. (immediate)
 - b. Continue to increase production efficiencies that **reduce the cost** of B.t.k., Green, and other selective biological pesticides for forest pest control.
2. **Increase worker safety**, awareness and protection standards for handling, mixing and applying pesticides.
 - a. Handling, mixing and loading concentrated chemical pesticides are the most risky activities in many pesticide application activities. Ensure that those working with concentrated pesticides follow rigorous standards for using personal protective equipment and techniques that reduce the risk of spills or exposure.
 - b. Eye contact and inhalation are the highest risk pathways of pesticide exposure to applicators. Ensure applicators are provided and trained to use appropriate personal protective equipment and techniques that reduce the risk of exposure.
 - c. Resource: View “Worker Protection Standard” descriptions in order to understand the elements of and procedures for worker protection that are standards in the USA. <https://www.epa.gov/pesticide-worker-safety/agricultural-worker-protection-standard-wps>
3. Ensure that **standards for pesticide application** (timing, product quality) and effectiveness monitoring **are established and enforced**.
 - a. Ensure application timing and planning software is up to date.
 - b. Require reference plots be established and monitored on every operation. (immediate)
 - c. Develop a system of training and efficient “hot check” (making observations when the people doing the work are present so additional training can be provided immediately) and “cold check” (making observations after the people doing the work have finished and are no longer present) quality control procedures.
 - d. Determine the percentage of operations that will receive random quality control checks. (immediate)
 - e. Follow through to check and report to supervisors on status and quality for the planned randomly-selected operations. (immediate)
 - f. Conduct enforcement checks on higher percentage of targeted operations if problems in application quality are detected.
 - g. Provide feedback, analyze patterns and improve application timing or procedures to improve safety, quality and effectiveness of pest control.
4. Pesticide application work is highly precise and technical. It requires significant experience and training. Acknowledge operators who have demonstrated effective pest control accomplishments, worker and public safety, and non-target resource protection in the bidding process. **Avoid simple “lowest bid” procurement practices for pest control.**
5. Seek and **develop additional tools for direct insect control** such as NPV for major pests *D. sibiricis* and *L. dispar*.
 - a. Review relevant literature on NPVs that have been described for important Lepidopteran families and procedures for detecting, identifying, quantifying, amplifying and using NPVs. Example: https://www.fs.fed.us/foresthealth/pesticide/pdfs/DFTM_NPV_QA.pdf
<http://www.sciencedirect.com/science/article/pii/S0022201170900601>
 - b. Collect and test symptomatic larvae that are observed in Mongolia.

- c. Develop a system to publicize the effort to find infected larvae and the procedures for submitting promising samples to researchers. Acknowledge those who participate and contribute infected samples.
- d. Collapsing outbreaks are the most promising sources.
- e. Identify the most useful insect life stages and timing for collecting and testing viral loads in a specific population.
- f. Evaluate “Gypchek” the *L. dispar* NPV that has been developed in North America.
<https://www.fs.fed.us/ne/morgantown/4557/gmoth/manag/gypchek.html>
6. Ensure that **Emergency legal provisions** that allow and guide the federal government to use all available tools, including chemical pesticides, are available for rapidly responding to harmful exotic pest introductions when eradication is possible.

4. Research:

1. **Increase** the number of scientists and students who investigate forest insect and diseases in Mongolia.
2. **Collaborate with international organizations and individuals** to share experience and develop knowledge about similar pests, forest conditions and management practices. (soon)
 - a. Identify research needs assessment and timeline to adapt/develop 1.1 Silvics compilation to Mongolian sites and growing conditions. Implement action plan to address information gaps.
 - b. Develop communication channels and relationships with specific international organizations, agencies, and universities. Start with international researchers whose work is relevant and being cited in parallel Mongolian studies.
 - c. The Douglas-fir tussock moth (*Orgyia pseudotsugata*, DFTM) and western hemlock looper (*Lambdina fiscellaria lugubrosa*) are serious forest defoliators in western North America. Extensive survey, early warning, and population evaluation tools have been developed to understand insect population cycles and to determine where control actions should be implemented. Form a team with DFTM and hemlock looper researchers and managers from North America to develop similar tools for *D. sibiricus* and *E. jacobsoni*.
 - d. Identify opportunities and participate in educational exchanges on variety of forest science, forest management, forest entomology, forest pathology and pest management topics. The USDA Forest Service International Forestry program is an enthusiastic partner in developing productive exchanges.
 - e. Consider opportunities to join annual meetings such as the International Union for Forest Research Organizations IUFRO (<http://www.iufro.org/science/divisions/>), the Western Forest Insect Work Conference (<http://www.wfiwc.org/>), Entomological Society of America (<http://www.entsoc.org/>) or Entomological Society of Canada (<http://www.esc-sec.ca/>). Consider hosting a similar meeting that could include international specialists.
 - f. If offered specific questions, Ripley can attempt to identify individuals or research organizations in North America whose work involves similar areas and questions.
3. **Consider and integrate the timely observations, practical experience, local availability and knowledge** of Forest Protection Officers and Pest Control Operators and Forest User Groups.
 - a. **Collaborate** with Forest Protection Officers and Pest Control Operators and Forest User Groups on research project design, identification of research sites and site security, research implementation, and interpretation of results for adaptive management.

- b. Sponsor an **annual work meeting** of Researchers, Forest Protection Officers, Pest Control Operators and Forest User Groups to share knowledge, annual observations and planning for additional work.
 4. **Identify resistance mechanisms of trees and forests** to damage from forest defoliators.
 - a. **Develop methods to identify and track individual resistant trees during the course of outbreaks.**
 - b. Study potential resistance mechanisms that have been observed in resistant trees.
 - c. Investigate whether early instar *D. sibiricus* can mature on *P. sibiricus* in order to identify whether east-ward range shifts can occur if the climate warms.
 5. **Publish information in diverse ways** (meeting proceedings, scientific journals, and accessible “leaflets”) **to make information widely available** to academic researchers, forest managers and workers, and the public. (soon)
 - a. Develop “Forestry Extension” communication strategy and necessary university or research institute staff appointments to provide strategic technical transfer to specific audiences and high quality synthesized public information.
 - b. Acknowledge/reward university professors and research institute staff for extension publications and outreach activities (workshops, advertising campaigns) with similar status to peer-reviewed literature or formal scientific publication accomplishments.
 - c. Consider the USDA Forest Service “Forest Insect and Disease Leaflet” model for content and detail level about specific insects or pathogens for broad audiences with some forestry knowledge or interest. (Copy the address, below, or Google “Forest Insect and Disease Leaflet” to see the series).
https://www.fs.usda.gov/wps/portal/fsinternet/cs/main/!ut/p/z1/04_Sj9CPykssy0xPLMnMz0vMAfljo8zjQwgnNHCwN_DI8zPwBcqYKAfDIzgAM4GuhHEaMfj4Io_MaH60dhtSLMB2ECITMKckMjDDIdFQEHRNG/dz/d5/L2dBISEvZ0FBIS9nQSEh/?position=SubNavigation&pname=Forest%20Service%20-%20Forest%20Insect%20&navtype=SubNavigation&ss=11&pnavid=750110000000000&navid=750110120000000&ttype=main&cid=null
 - d. Two examples of state publications that effectively describe a caterpillar and control decisions are “*Winter Moth Identification & Management*” (<https://ag.umass.edu/landscape/fact-sheets/winter-moth-identification-management>) and “*Idaho Department of Lands Forest Pest Alert. Douglas-fir tussock moth defoliation in Kootenai, Benewah and Latah Counties*” (http://www.idahoforests.org/img/pdf/DFTM_PestAlert.pdf)
 - e. Consider the “Forest Health Highlights” model for accessible information on the status of specific insects or pathogens. https://www.fs.usda.gov/detail/r6/forest-grasslandhealth/insects-diseases/?cid=fsbdev2_027203
 6. **Investigate beneficial predatory and parasitic insects, birds and mammals in detail.** Quantify the control pressure they exert on pest insects. Identify and advocate for actions which protect and augment their effectiveness.
 7. Conduct basic **Forest Pathology investigations** to identify and develop appropriate management recommendations for forest root, stem, shoot and foliage pathogens and diseases. Basic information that would be useful is similar to that included in “Forest Disease Management Notes,” USDA Forest Service, Region 6, Forest and Grassland Health, Publications.

5. Public Information and Forest Stewardship:

1. **Educate policy makers about the characteristics and benefits of resilient forest ecosystems. Increase support for integrated forest management activities** that improve tree vigor and prevent damage from forest insect outbreaks. (soon)
 - a. Schedule meetings between specialists such as forest health researchers or FRDC staff and policy makers to improve trust and explain concepts.
 - b. Develop local examples of demonstration sites and effective interpretive materials so non-scientists can understand important research questions and the observations that are occurring.
 - c. Arrange tours so policy makers can demonstrate leadership, increase their knowledge, and observe concepts being implemented on familiar sites.
2. Educate the public about the **benefits of resilient forest ecosystems and management strategies** to increase sustainability.
 - a. Develop a communication strategy that is rooted in Mongolian culture to make effective educational and forest protection messages available to public audiences in markets, schools, libraries, soum centers, government offices or other sites.
 - b. Train Forest Protection Officers and those who interact with the public to be familiar with key concepts and speaking points about forest resilience and protection.
 - c. Develop attractive informative letters or hand-out brochures to give local people at forest protection public meetings and when direct forest pest control notifications are being made. Such materials can include regulatory and safety information, and dates the specific operations are planned, but also can include educational messages about sustaining resilient forest ecosystems and preventing forest fires. Example: An 8 ½ x 11-inch paper can be printed on both sides and folded in half to be a 4-panel brochure or into thirds to be a 6-panel brochure. Design 4-panel brochures to have one panel with forest ecosystem education and fire prevention messages; design 6-panel brochure to have 2 panels for forest ecosystem education and fire prevention messages.
3. Make **connections with cultural concepts** of animal husbandry and land stewardship. Example messages: Strengthen the forest by thinning activities that remove the weakest trees. Grow fat trees that will be stronger every day. Fat trees can survive when adverse weather occurs or pests arrive.
4. Draw on and **value local experiences** regarding water management, fire prevention, and desirable forest conditions that supply traditional non-timber forest products.
5. **Create pride and motivation for short- and long-term protection** of forests, legacy habitats (like large standing dead trees with woodpecker nests, trees that resist defoliation, thatch ant nest mounds, etc.), and beneficial predators and parasites. Local and personal pride can result from receiving recognition and appreciation, positive publicity, and financial incentives.



Figure 3. Beneficial predators such as birds and ants can exert control on forest pests that extends the time between outbreaks and makes outbreaks less intense. Left and right photos from Gantulga Bayandonoi 2012 "Birds one of the wonders of Mongolia" ISBN: 978-99962-0-822-5

Brief Agenda of Major Activities June 5-June 19, 2017

- June 5, 2017: Internal meetings and briefings (UN-REDD Mongolia). National pest control activities, operations and pest studies (FRDC). Security Briefing: UN Department of Safety and Security.
- June 6, 2017: Institute of Geography and Geoecology. Institute of General and Experimental Biology. Institute of Plant Protection. Shim Company.
- June 7, 2017. Field trip to Green Zone Forest and Terelj National Park.
- June 8, 2017: Khairkhan soum of Arkhangai Province.
- June 9, 2017: Microbiological pest control in Khairkhan soum.
- June 10, 2017: Selenge soum Bulgan Province.
- June 11, 2017: Selenge soum.
- June 12, 2017: Selenge soum. Forest pest control using ground methods that carry chemical pesticide on diesel exhaust. Return to UB.
- June 13, 2017: UB. Prepare for workshop.
- June 14, 2017: UB. Prepare for workshop. Meeting with US Embassy. Meeting with FAO.
- June 15, 2017: UB. Workshop and Discussion.
- June 16, 2017: UB. Write up trip summary and develop recommendations.
- June 17, 2017: UB. Write report.
- June 18, 2017: UB. Submit draft report.
- June 19, 2017: UB. Discuss report and findings with UN-REDD. Meeting with Ministry of Environment.



APPENDIX 1:

Trip Report: Major activities, notes and informal observations

NOTE: These are Karen Ripley's notes and perceptions of brief introductions and site visits. Any errors or omission in fact or perception in these descriptions are her responsibility. Assistance with language translation and interpretation have been provided by Nominchuluun.B and Bilguun.O of UN-REDD and Balgalamar Tuulaikhuu of School of Agroecology, Mongolian University of Life Sciences. Their assistance was critical to the success of this assessment and is sincerely appreciated.

June 5, 2017:

Security Briefing: UN Department of Safety and Security.

Three major safety and security problems likely in UB and Mongolia are opportunistic property crimes (pick pockets, purse stealing); traffic accidents (pedestrian or rider); building construction site accidents that impact adjacent streets. UNDSS must be kept well informed of Ripley's location.

Internal meetings and briefings (UN-REDD Mongolia).

In order to accurately quantify the baseline, status and trends of deforestation and degradation, UN-REDD continues to gather forest survey data using several methods (taxation survey; GIZ definitions; remote sensing). The methods may be inconsistent year to year. The trends don't seem to indicate that insect activity is causing as much forest destruction as the affected area reported by FRDC and the proportion of the national forestry budget that is being spent on pest control activities (about 60%) seems to indicate. Continue to improve methods and comparisons in order to identify long term impacts of pest activity.

National pest control activities, operations and pest studies (FRDC).

The goal is to decrease pest insect activity to 60% of 2015 area by 2020.

Extensive annual operations to detect and assess insect populations (detection, species identification, extent; phase of outbreak; whether meets impact threshold of approximately 100 insects per tree, indicating that 75% of needles will be eaten; absolute density of insects) and to prioritize and order suppression (by certified operators, with permit) of forest defoliating caterpillar outbreaks. The FRDC has 5-8 research teams that live and work in dispersed forested areas and one central office. They intend to add 2 more field offices with staff.

Chemical pesticide applications were discontinued by the federal government in 2010. Control activities are targeted to the appropriate life stage of the insect, meet 7 legal standards, and comprise about 150,000 ha per year. They include aerial applications of B.t.k. (now about 1/3 sourced and produced in Mongolia) and "Green" Metarhizium anisopliae fungus; ground application of biological pesticides; and diverse mechanical reduction methods (belts around trees, pheromone trapping, light trapping, egg collection).

The FRDC is striving to target areas that are important to tourism or local uses, and to prevent widespread tree death from serious outbreaks.



The federal government is not receiving its legal proportion of the forest revenue earned in the provinces.

June 6, 2017:

Institute of Geography and Geoecology.

Employs several entomologists whose work includes investigating insects and diseases and climate. Develops systems to assist in forecasting phases of outbreaks; how tree growth relates to insect numbers and damage; weather/climate relationships with pest populations; development and evaluation of suppression activities such as stem bands and light traps; the community structure, diversity and factors that influence number and density of stem and bark insects; and identification of conifer foliage diseases. Lures for pheromone trapping are expensive. Researchers would like to collaborate in many ways. Are there opportunities for testing pheromones? Publications include Common Insects of Mongolia (468 pages, English).

Institute of General and Experimental Biology.

Has performed research on forest pests since 1980. Has a laboratory of Entomology that is defining the taxonomy and distribution of all insects in Mongolia. Publications include a guide (75 pages) to the important forest pests (photos, descriptions, life cycles, control timing) of Mongolia.

Institute of Plant Protection.

*Identify diseases, pests and weeds of range, hay, forest and green areas of Mongolia in order to develop methods and technologies for prognosis and control, including commercializing new technologies. Includes entomology, rodent, microbiology, food safety laboratories. Detected and developed production methods for Mongolian strain of B.t.k., "Green" *Metarhizium anisopliae*, and *Beauveria bassiana*. Goal is to produce inexpensive pest control methods that have no unintended consequences.*

Shim Company.

Factory southwest of UB beyond airport. Produces 1/3 of the supply of B.t.k. used annually in Mongolian pest control. Liquid preparation – when make dry formulation about 40% of the spores die. Also produces "Green" and some rodenticide products. Has a close relationship with Plant Protection Institute. Is only using about 15% of the factory capacity and would like to increase production. Would be good to diversify sales beyond forestry.

June 7, 2017: **Field trip to UB Green Zone Forest and Terelj National Park.**

*National Parks and UB Green Zone Forest are a priority for treatments because of tourist scenery and forest cover. **Site 1:** Across river from main lodge and cabin facilities. Initial difficulty locating site. Treated 8 days ago by air with B.t.k. Had 120-130 *D. sibiricus* before the spray treatment. Used large mallet and beating cloth to dislodge remaining larvae. They weren't particularly active so likely had B.t.k. ingestion and effects. PPI collected some (black color – they are gray when there's more food) to test for B.t.k. activity. No reference stand or measurements taken to ensure that active B.t.k. landed on site and/or had impact vs. natural mortality changes in a similar no-treatment sites. **Site 2:** Back across river through village to hillside stand treated 9 days earlier by air with Green. Have a procedure for regular visits to*

observe larvae fallen onto small (2 m²) fixed tarp, then at 14 days beat any remaining larvae from nearest tree. (We disturbed this procedure by putting our beating cloth at the fixed tarp site and beating their sentinel tree. There seemed to be little awareness of the importance of monitoring activities and protecting the soundness of reference site. Was told it existed, but didn't visit additional untreated reference site 1 km away. Late lunch hosted by Ranger, back across river at visitor ger.

June 8, 2017: Khairkhan soum of Arkhangai Province.

Long drive included large meal provided by the generous mother of B. Batchudur.

Met local FRDC staff, Provincial forester, and company staff at lush site with tall grass, iris, peony, buttercup, strawberry. Had been treated by air with B.t.k. two days prior. Used beating mallet and cloth. Many sluggish DESI fell. A few Siberian pine among the well-spaced larch forest with some larger gaps. I measured about 130 ft² basal area/acre (we tried to convert to m³/ha but didn't have confidence in the calculation ... forester also thought stocking was fairly low) and observed good recent growth from coring a co-dominant larch with about 11 growth rings to the inch. Site was sprayed in 2012 and 2009. When I asked why they sprayed in 2017, they said it met the 100 larvae/tree threshold. There was no unsprayed reference stand for this site so could not discern what would have happened with no treatment.

Traveled to campsite occupied by researchers whose work involves using remote sensing to detect and understand impacts and factors related to defoliation.

June 9, 2017: Microbiological pest control in Khairkhan soum.

Visited site in 4th year of Jacobsen's spanworm ERJA outbreak. Trees not currently defoliated. Larvae difficult to find in lower branches. Carpenter ants present. Observed small thatch ant-type mounds made of fine wilted larch needles and maybe grass clippings. Observed secondary insects in dead saplings (Ips, Scolytid, Cerambycid, Buprestid). Woodpecker excavation of deep wood borers. Few large dead trees for snag habitat. Listened to recent PhD recipient from University in Inner Mongolia present research on using Landsat spectral analysis for detection and quantification of ERJA distribution and damage. SE aspects were most severely damaged due to: prevailing wind coming from NW; more dry physical conditions influence less dense forests; less dense forests trees receive more direct sun that supports larval development.

Ganzorig did work to identify risk factors for DESI. He will show me later.

Drove (long time) to airport that had staged Air Tractor plane and supply of Shim-produced B.t.k. for spraying 9,500 ha in vicinity. B.t.k. was delivered the day before – they don't want it to heat in the sun. Work will require 2-3 days of good weather. Plane's tank carries 1100 liters, but only load 1000 when weather is hot. Discussed when/where nozzle calibration and spray characterization occurred. Ganzorig was trained in these standards in 2003 by John Ghent and Amy (Oiken) Hill. I am unsure when/how this is done now and whether it is ever spot-checked/repeated. Ripley shared practical insight into when it should be repeated and her habit of doing surprise spot checking by driving into treatment area and observing B.t.k. spray deposition on truck windshield.

Davaadorj Enkhnasan gave presentation on DESI distribution and forest habitat. After 2-3 years of defoliation, trees can't refoliate and are killed by secondary insects. Lots of questions about definitions of threshold populations and Mongolian concept of "Golomt." (I don't understand the details of these

concepts and the best ways to express specific characteristics. It seems that specific vocabulary is not common). Snowfall protects larvae overwintering in soil. Maximum temperature in warm season indicates rapid larval maturation rate. Final instars are large and eat a lot of foliage. If average annual temp rises 2 degrees C, DESI is predicted to move east from Khenti to another province. But there's no larch there! – In its last instar, DESI can eat Siberian pine, but effects of climate change and performance of young larvae on Siberian pine are not known.

I delivered a PowerPoint presentation on the 2016 Asian gypsy moth eradication effort in Oregon and Washington (previously presented to the Western Forest Insect Work Conference, May 2017 in Jackson Wyoming, USA). Aircraft and spraying technologies were familiar to audience. The number of pheromone traps deployed to follow up (direct control and effectiveness monitoring) after spray application were shocking to them.

Ripley will follow up to consult with John Ghent to provide Ganzorig replacement software that modelled insect development to identify spray windows.

June 10, 2017: No spray application from airport due to local wind and rain.

Selenge soum Bulgan Province.

Drove to camp of operations team that is using Italian backpack spraying equipment that shoots/sprays water-diluted Karate chemical mist up into tree canopy.

Viewed evening demonstration in stand that had DESI and LYDI (estimated >100 larvae per tree when beat 3 lower branches of large tree onto cloth; 17 DESI and 3 LYDI dislodged when shook 4" DBH sapling onto cloth; easily 100 DESI pupae on dominant tree). Took 2 cores from co-dominant trees; recent growth was about 25 rings to the inch. Bases of trees were blackened by past fire.

"Karate" is trade name for lambda-cyhalothrin, a pyrethroid chemical. Pyrethroids are man-made chemicals that are similar to natural insecticides called pyrethrins. Pyrethroids disrupt the normal functioning of the nervous system in an organism. Effects depend on how much lambda-cyhalothrin is present and the length and frequency of exposure. Human health effects also depend on the health of a person. Human data are not available on the break down and excretion of lambda-cyhalothrin, but rats absorbed about half of the dose they were exposed to and excreted it in urine and feces.

There are many product formulations made with the active ingredient lambda-cyhalothrin. It is critical that operators understand the specific, detailed precautions, instructions and return intervals associated with the product they are using. No English label was available. Ripley saw one product that required 7 days preharvest interval for hay that would be dried but 0 days re-entry prohibition for grazing in treated areas. Another product label described dilutions with oil, but cautioned against diluting or carrying lambda-cyhalothrin with diesel.

See npic.orst.edu/factsheets/l_cyhalothrin.pdf for some research summaries and health safety information on active ingredient lambda-cyhalothrin. Key points Ripley noticed (this is an incomplete analysis; exposure can be mitigated by specific formulations and delivery methods) included ... Reactions among people exposed while handling relatively pure or concentrated lambda-cyhalothrin included facial tingling and burning sensations; these reactions generally occurred within 30 minutes of exposure and lasted for 6 hours to 2 days. Some field workers (4 of 38) reported adverse effects from exposure such as

skin irritation, burning sensations, skin rash; all had handled concentrated lambda-cyhalothrin and 3 of 4 had also applied diluted solutions. Other symptoms may include dizziness, headache, nausea, lack of appetite, and fatigue. In severe poisoning, seizures and coma may occur. Half-life on plant surfaces is 5 days. Low water solubility and high potential to bind to soil results in low potential to contaminate ground water. Highly toxic to fish, with the potential to accumulate in fish. Low toxicity to birds. Highly toxic to bees then they eat or contact chemical, but no increased risk was noted to bees in field study.

Camp had handwashing station (with bar soap) made from cut of 2-liter soda bottle.

Pesticide and equipment storage area located away from sleeping and cooking tent was signed and enclosed in tarp. Karate package had number 91465-08-6. Chinese made. The instructions that were translated to me, were to “Mix 17 L water with 220 ml Karate to treat 1.8 ha.” So the Karate is fairly highly concentrated.

Worker clothing: cotton gloves with rubber pads, calf-high boots, distinctly colored long sleeve orange and dark blue cotton shirts and dark blue pants, cotton hats with c. 2” brims; masks with a valve, sunglasses. Workers did not wear backpack sprayers when they were being filled. Truck carried tank with river water to dilute Karate (in large plastic containers). Ripley would recommend mixer/handlers wear eye protection, rubber gloves and waterproof apron. Mixers should use technique of adding most of the water to the spray tank, then adding the concentrated chemical, then topping off with the remaining volume of water. Workers wear spray clothes to and from camp, riding in van. Unsure about when/where they changed or laundered clothing. They reported sometimes having skin irritations. When that occurred, the area was washed with water. Workers are given milk and yogurt with their meals, to address potential exposures. (I was told this strategy is common in Mongolia to support many kinds of workers using many kinds of toxic materials – but the medical interaction of dairy products with the body and chemical toxins is not familiar to me, perhaps, minimally, it prevents dehydration and encourages excretion but there may be more complex physiological or metabolic interactions).

Saw some Mongolian literature that listed preharvest intervals for food of 10 to 30 days. Strawberry and raspberry plants in sprayed area were in flower so would not be harvested yet.

Spray equipment is Italian-made and has a buzzy engine noise as is being used. Operators control the output of the spray. Each sprayer’s tank load lasts about 15-20 minutes. Spray can reach 17 m. Workers are directed by the lead Biologist and walk 20 m apart. It can be difficult for spray to reach the tree tops in dense stands. In the demonstration, the Biologist was not wearing personal protective equipment (PPE) such as hat, mask, gloves to follow or enter spraying operation to interact with workers if needed.

Discussed notification of local residents. Governor prepares letter ordering treatment. Message is verbally delivered to families and homes near area several days before the treatment. (Beekeepers down-valley were informed). I believe I heard that forest is closed to use for one week. Unsure whether any written letter or handout with detailed instructions, source of additional information, and other messages is provided (but don’t think any handouts are prepared or left).

Work is assessed within 3 days by local team. If not acceptable, chemical application will have to be repeated at company’s expense. FRDC also checks and reports accomplishments and quality of work to Ministry of Environment.

I asked Jakdag's opinion – the FRDC prefers non-chemical methods. The Province is paying for this specific work. Provinces often choose it because it is much less expensive than biological methods.

Ground applications with chemicals cost \$8500 MT per hectare; with B.t. cost \$48,000 MT per hectare. Aerial applications with chemicals cost \$11,500 MT per hectare; with B.t. cost \$50,000 MT per hectare.

Clearly, B.t. is very costly compared to chemical products and is the most expensive element of aerial applications.

June 11, 2017: Selenge soum. *From this camp went up-valley to birch (70%) and larch (30%) forest that had been sprayed the day before with Karate using Italian made backpack ground spray equipment. Label restricts application to <25 degrees C; <50% Relative Humidity (RH); windspeed <5m/sec. I asked about rain concerns. Operator/Biologist received weather forecast from nearby station. Rain too close to operation would be avoided by following RH restrictions. Rain shortly after application is ok.*

Some holes observed in birch leaves. Didn't record the defoliation of the larch. Pre-spray 4-branch beating sample delivered 54 larvae indicating over 160 per tree. A small birch tree had been shaken and estimated to have 15 larvae. Many dead LYDI on ground at the base of birch and larch trees. Dead birch leaf rollers (family Tortricidae) observed. Some larch regeneration (.5 – 1.5 ft seedlings) present, estimated at 3-6 years old. Dying butterfly, likely "Aporia crataegi." Tenebrionid beetle "Upis ceramboides" was moving slowly, but not seizing. Livestock tracks in the road mud indicated animals had been through the area recently and horses were pushed through the area by a herder while we were present.

Reference plots. Was shown a pair of similar birch trees marked with red ropes tied around trunks. One tree was sampled prior to spraying. Both trees were sprayed. Second tree available to sample after spraying. There are either 4 or 5 such pairs of trees in the spray area. Two pairs are birch and two pairs are larch. Some are for the company to check. Some are for the local government to check. The FRDC can check anything anywhere. (Doesn't seem to have been a "blind" test of the applicators).

After meal, drove to steep rocky cliff area and climbed up to look at 2016 Gypsy moth egg masses in cracks and protected sites. (2017 egg masses haven't been laid yet). Workers sample 25m x 25m area to count and make population forecasts. Can count on smaller area if cliffs are too steep. Hazards of area: steepness (falls), loose rocks (injury), snakes. Very difficult locations to count. Extremely difficult to view and collect a high percentage of egg masses. Discussed techniques to hold/cage egg masses and let the beneficial Telenomus wasps emerge. Unsure whether this technique is used.

Drove out to Baruunnburen (soum), Selenge province. Stopped at OXCT Company office, but Ripley didn't know situation and didn't participate in any meeting – people we intended to speak with might not have been there. Had lunch nearby. Drove to view Amarbayasgalant Khiid. While there, met Buyanzaya Batjargal, Vice President, Mongolian University of Life Sciences. His specialty is Economics. We described the forest pest situation and goals of UN-REDD rapid assessment trip. Ripley's Interpreter Amura (Balgamar Tuulaikhuu) works at this University's School of Agroecology. Arrived at field camp of pest suppression company OXCT at about 9:00 pm.

June 12, 2017: Forest pest control using ground methods that carry chemical pesticide on diesel exhaust. Return to UB.

*Tent camp serves 15 people. Had soda bottle handwash and bar soap holding station. Pesticide “Karate” is stored in lightly fenced, but heavy-tarp-covered and signed area on wide, braided floodplain at base of hill. Label described “PROD. NAME: LAMBDA-CYHALOTHRIN 50g/l EC. BATCH NO: 20170331. 10LTS*2/CTN. DATE OF MAN.: APR 2017. DATE OF EXP.: APR.2019. IMPORTER: URGAM CO., LTD. PLACE OF ORIGIN: MADE IN CHINA”. Packaging is plastic jugs in some cardboard boxes. (When I asked why it was near the river, was told it was intended to “hide” it from the ranging horses that are curious and would rub and lick and sleep near it. I thought they said there was a tarp underneath but the packaging visible at the edges was on grass and gravel.)*

Travelled up-valley to see demonstration of Chinese-made equipment (although they can disassemble this equipment and can repair/replace individual parts). A backpack structure includes a 4 L tank for diesel, a 2 L tank for the concentrated Karate; an engine that burns the diesel and sends the exhaust up through a 3” diameter exhaust tube with its opening oriented about 45 degrees towards the ground; handle that releases small volumes of Karate into the diesel exhaust stream where it’s volatilized and emitted partly as hot, white smoke, but likely some invisible vapor too. (Unsure whether the diesel is burned or just heated; the Karate is volatilized, but not burned (oxidized)). The applicators have a plastic apron that protects their buttocks and upper back thighs and knees from any liquid drips (but doesn’t reach the tops of their boots –they said it would be awkward to walk with). The machines are not worn during filling. Each machine had a funnel tied on for filling the tanks. The workers wore regular clothes: calf-high boots, jeans, t-shirt under long sleeve shirt, cotton mask, cotton gloves with rubber palm, heavy cloth hat with 2” brim or cap and “hoodie” sweatshirt covering head and neck. No eye protection observed in use. A supervisor wearing a heavy long-sleeve camouflage coat and long pants and hat and boots entered the treatment area to help restart one of the machines. Unsure whether he had eye protection, mask or gloves.

As workers walk through the spray area, they didn’t direct their equipment upward (its angle is fixed downward) but the smoke blew and drifted and rose among the trees. Sometimes the workers were enclosed in the smoke. Was told that when working on long hillsides pairs of applicators have a walking pattern perpendicular to the prevailing wind. The downwind applicator starts walking across the prevailing wind. An upwind worker delays then walks parallel to him. The pesticide blows downwind into the tree crowns and doesn’t contact the workers.

The workers work from 6:30 to 1:00pm. They stop from 1 to 4 pm when it’s too hot. They work from 4-9 pm. The company has 10 backpack machines. The tanks are refilled 7-8 times a day. Can cover 14-15 ha/tank and crews can total 300-400 ha/day (maybe all the crews – my math doesn’t seem accurate). They have 5000 ha on their contract to treat forests in Selenge soum.

I asked about their clothing and was told it was “second hand” (but the items looked pretty new, fashionable, good fitting and high quality to me). The applicators change clothes when they get back to camp and keep their spray clothes near the chemical storage area. They don’t take this clothing into their sleeping tents because it has a faint odor. They wash their own clothes in basins of river water brought away from the river. Each person washes his own clothes and puts them on the ground to dry during the mid-day break. Unsure whether/when boots are changed.

They wash their hands at mid-day break. In the evening they wash their hair and faces in river water brought away from the river.

They said their eye protection was broken, gets too steamy, and the wetness causes skin irritation. Heavier gauge paper masks with flexible metal nose fittings interfere with glasses' fit. Sometimes the workers get irritated skin and skin rashes on exposed skin at the beginning of the season, but they get used to it and such irritation subsides. They are given milk, yogurt and cream in the evening to mitigate exposure to toxins.

I asked about the effectiveness of the Karate and this delivery system. This is the first time this area has been sprayed in many years. They are treating DESI here and ERJA in the eastern part of the soum. Jakdag walked through and observed some fallen larvae in the area that had just been treated, but he said it had an odor so the rest of us did not go investigate. The company Director is satisfied that it kills lots of larvae. A company Engineer checks specific GPS points. Rangers in the soum check the efficacy (anywhere in the treated areas), but I don't think there are specific untreated reference sites.

This demonstration occurred near a series of little tourist cabins. And while we watched, a herder and his sheep moved onto the site for grazing (not just pushing them through). I asked about local notifications. The local governor writes a letter that describes what will occur, who will check the results, establishes a local oversight panel, says bees must be moved, and closes the forest for fruit, leaf and nut collection for 2 months after treatment. The position on grazing is that it is non-toxic to mammals, so they don't make official recommendations about animals. (And they said the chemical doesn't fall to the ground; it rises into the trees). They inform/tell the local people about the treatment plan. They don't leave any written notices behind. Note, the tourist camp with several wooden cabins in the spray area currently has no occupants except a year-round caretaker and was suggested to stay closed for 10 days. (Don't know if that's followed, but this site is not really on the most central travel routes to receive casual tourists).

Electrical poles are laying along the valley so electrification must be planned for the area.

Went to different site that was partly sprayed 2 days ago. As approached, two machines were being filled next to truck. The Karate handler wore sunglasses and gloves.

In the larch forest, lots of dead DESI. One butterfly (likely "Aporia crataegi") observed. Prior to spraying, the smaller trees had 150-180 larvae per tree. The large trees were estimated (from small trees and large branch beatings) to have 2500 larvae per tree. Most trees were brown and missing most needles, but some needles remained.

I asked why they didn't treat earlier, before so much foliage was eaten. The business owner/Director said that his contract with the aimag governor actually specified that the work begin June 13. But he knew from experience that they needed to start spraying in late May. He knew he needed to start work training his crews, creating maps (already worked in this area in 2009 so had previous maps and updated them for 2017), and acquiring the Karate product May 1. Although there was a delay, he did get paid for this early work.

There was a meeting May 12 in the aimag center that included the local Forest Unit Directors, local Rangers (from every soum), and Forest specialists. The OXCT Company Director told them they should have prepared to start earlier. They started notifying and phoning people. They knew about insect populations

in the area from FRDC survey results. They requested funds to spray more area than they'd been contracted for.

I asked him about how the bidding process worked – whether the lowest bidder always received the contract. I didn't understand the entire description but there are several methods of procurement and, in this case, his experience was recognized and he didn't have to have the absolute lowest bid received. Sometimes accepting the lowest bid is required.

The Province decided not to use B.t.k.

Group also looked at adjacent 2500 ha area that hadn't been sprayed. Right at the boundary with the officially treated area, there had obviously been some drift effects – dying DESI were observed. As we went deeper into the untreated area the trees were 99% defoliated. Dead DESI were on the ground. Some dead in the trees looked like they had potential for NPV. Few live, active larvae were still in the trees, had they walked away from the defoliation? There was one “resistant” tree on a ridge. It was an upward growing branch on what was mostly a broken snag trunk. There were a couple large DESI larvae on it, but it was amazingly green.

As we walked downhill toward more green larch trees along general perimeter of defoliated area, there were more larvae present, spreading from the defoliated area. Observed (and researchers collected) some more potential NPV-infected larvae. Pupation was starting. One, lone Scots pine present on site was not defoliated. Did not see any other pine trees in area.

Director expects that these larch trees will refoliate, especially if it rains.

He mentioned thinking about prior experience in military with tanks, setting smoke bombs to hide or divert attention away from the tank operations. He wondered if you could disperse smoke bombs and set them off remotely or with a delay to avoid workers being in the treatment areas during pesticide release. I don't know if “bug bomb” technology that's generally used in closed spaces like rooms or homes for killing fleas and roaches would provide enough horizontal coverage.

At 11:15 departed this site to go back through Baruunnburen and return to UB.

June 13, 2017: Preparing for workshop at UN-REDD office, UB. *Met Richard Slaby, project coordinator for Czech Republic & Mongolian joint project “Development of Forests and the Gene Pool of Local Forest Tree Ecotypes in Mongolia 2015-17”. He described the project goals and activities, north of UB. It started as a nursery development project (in Scots pine area) but needed to develop many integrated elements of forestry and community to harvest sites, make birch charcoal and dust, manage forest, develop educational center, etc to use their tubed, high quality seedlings. Went to an evening reception for an 8-day visitor group of forestry professionals from the Czech Republic. Spoke to Jiri BILY who is a professional entomologist in the Czech Republic. He is interested in the forest pest and protection situation in Mongolia, but didn't see much of it in his short visit. He will be a good contact for the Gemamyces picea situation in Alaska.*

June 14, 2017: Preparing for workshop, UB. *Met with Chris and Bilguun to review concepts for PowerPoint on North American Philosophy and Methods (with English script in “notes”) and recommendation list. Continued working on recommendation list and associated PowerPoint notes. Amura arrived at about 11:30 to start translating.*

Traveled to US Embassy to meet Onejin Wu (Environment, Science, Technology and Health Officer) and Daria Purevsuren (Environment, Science, Technology and Health Assistant) for about one hour. They showed interest in situation, assessment effort, and recommendation concepts. Daria recently traveled to USA for Forest Service workshop on Climate (Davis, Tahoe, Washington DC). She will try to attend workshop.

Amura and Nomi still working to translate and make copies. Chris and I met at 6:00 pm with FAO Chief Technical Advisor Andrew Inglis (who works with Forest User Groups) and recent FAO retiree Kevin Gallagher (Entomology graduate from UC Berkeley) who continues to be involved in several agricultural projects. Kevin was seeking a supplier of B.t.k. for a cabbage moth suppression effort. I provided the Shim phone number from a B.t.k. container label photo in my phone. Andy recommended speaking plainly and specifically using and emphasizing the word “thinning” in my presentation.

June 15, 2017:

Workshop and Discussion, Puma Center, UB. *Delivered one-hour PowerPoint “North American Philosophy and Methods for Pest Control” (with slides translated to Mongolian and simultaneous translator providing an approximation of English script) and 30-minute list “Ideas for Improved Forest Protection Activities in Mongolia” (abbreviated in Mongolian on PowerPoint slides, full statements translated to Mongolian on paper handout, and English script approximation provided to simultaneous translator).*

June 16, 2017: **Write up trip summary and develop recommendations, Hotel 9, UB.**

June 17, 2017: **Write up trip summary and develop recommendations, Hotel 9, UB.** *Booked individual travel for Gobi trip June 20-23. Emailed travel itinerary to UNDSS. Received confirmation of its receipt.*

June 18, 2017: *Unable to successfully e-mail draft report to Chris Dickinson for review.*

June 19, 2017: **Finalize report. Discuss report and findings with UN-REDD. Meeting with Ms. Tungalag.**



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