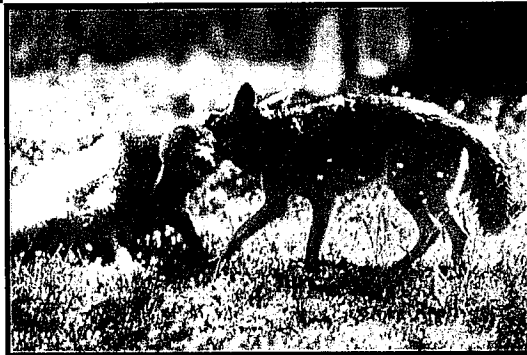


USDA/APHIS/WILDLIFE SERVICES **RESEARCH NEEDS ASSESSMENT** **2006**



Larry Clark, Team Leader (WS/National Wildlife Research Center)
4101 LaPorte Avenue
Fort Collins, CO 80521-2154
and
David Nelson (WS/Eastern Regional Office)
Kirk Gustad (WS/Western Regional Office)

May 22, 2007

INDEX

Research Needs Assessment Report	Pages 1 – 18
Reassessment of WS Research Needs (NWRC Director memo)	Appendix I
WS Research Needs Assessment (WS Deputy Administrator memo to WS Program)	Appendix II
WS Research Needs Assessment (NWRC Director memo to WSNAC)	Appendix III
Current APHIS/WS Methods Development Research	Appendix IV

RESEARCH NEEDS ASSESSMENT

UNITED STATES DEPARTMENT OF AGRICULTURE ANIMAL AND PLANT HEALTH INSPECTION SERVICES WILDLIFE SERVICES

Larry Clark, Kirk Gustad, David Nelson

MAY 2007

BACKGROUND

Beginning in 1989 the Wildlife Services (WS) Management Team determined that a national research needs assessment would be conducted every five years. For the first assessment, a survey of all WS State Directors resulted in a list of research needs and priorities based on species and affected resource groups (Packham and Connolly, 1992, "Control methods research priorities for Animal Damage Control", *Proc 15th Vertebrate Pest Conference*, J.E. Borrecco and R. E. Marsh eds., Pp 12-15). In 1991, the WS Program convened an "Expert Panel" of stakeholders in science, industry, agriculture, and the environment in Denver, Colorado, to identify research approaches to address the wildlife damage problems and needs identified in the 1989 survey. In 1996 and 2001 two additional WS program-wide Research Needs Assessment were completed (Bruggers, et al. 2002. Wildlife damage management research needs: perceptions of scientists, wildlife managers, and stakeholders of the USDA/Wildlife Services program. *International Biodeterioration & Biodegradation* 49:213-223). These Research Needs Assessments (RNA) guide the WS Methods Development research planning and have been used by the National Wildlife Research Center (NWRC) Director for guidance, along with Congressional Directives, Deputy Administrator input, input from external sources, and input from stakeholder groups, in allocating NWRC resources to specific research projects that address the WS Program's priority research needs.

As part of the process to improve and strengthen its research, and better align the research with WS Program and customer needs, the NWRC reorganized its research efforts in 1996 into individual multiyear, multidisciplinary projects. Research projects currently are aligned under four Research Program Managers for bird, mammal, product development, and wildlife disease research. These research projects address specific areas related to research priorities identified by the RNA process. Projects are of 3-5 years duration, have clearly stated goals and objectives, projected milestones, expected outputs, periodic reviews, and annual progress updates (e.g., NWRC Annual Highlights Report and Annual Report of the NWRC for Government Performance and Reporting Act).

Five years have passed since the 2001 survey. This report summarizes the input for the 2006 survey from WS State Directors, NWRC scientists, members of the National Wildlife Services Advisory Committee (NWSAC) to the US Secretary of Agriculture, state natural resources Directors through the Association of Fish and Wildlife Agencies, and the Wildlife Management Institute. This report lists the submitted research needs of those needs considered most important to the eastern and western regions, the NWRC, and the Program as a whole.

METHODS

The Animal and Plant Health Inspection Service's Wildlife Services Program has established a means of identifying and prioritizing wildlife conflicts and risks needing research attention through the use of a WS Research Needs Assessment (RNA) process conducted every five years. In this process, WS operational personnel from the state offices of the Eastern and Western Regions, as well as researchers from the National Wildlife Research Center (NWRC) are surveyed to identify the most important research needs. Previous assessments were conducted in 1989, 1996, and 2001. Members of the National Wildlife Services Advisory Committee (NWSAC), Wildlife Management Institute, and state natural resources Directors through the Association of Fish and Wildlife Agencies (AFWA) requested the opportunity to be involved in the WS program's 2006 RNA process. Representatives from each of these groups were invited by the NWRC Director to provide input to the RNA survey. In early February 2006, the NWRC Director initiated the 2006 RNA. In late February 2006 the WS Deputy Administrator and NWRC Director, respectively, solicited from WS State Directors, NWRC scientists, and NWSAC members, their three (in most cases) most important research needs. By May of the same year, the NWRC Director had received submissions from all WS State Directors representing 50 states, 32 NWRC scientists, 3 NWSAC members, a summary list from the Wildlife Management Institute, and a compiled list from state natural resources Directors sent through the Association of Fish and Wildlife Agencies..

Individual respondents' input was reviewed and categorized into a data matrix. Data were categorized as to the animal group (e.g., mammal, bird, reptile), species (e.g., beaver, starling), broad problem area (e.g., property protection, livestock protection, human safety), the type of damage (e.g., predation, disease), research needed (e.g., toxicant, repellent, information), and a summary of specific requests for research. From these syntheses several summary statistics are reported.

NWRC does not have the resources to address all the listed needs of the WS program. Therefore, identified research needs are used by the WS/NWRC Director as principal guidance for prioritization, along with Congressional Directives and Deputy Administrator guidance, in allocating NWRC resources to specific research projects that address the WS Program's priority research needs.

Bird Species Commonly Reported as Causing Problems: Of the number and diversity of bird species within the United States, only a few are identified as negatively impacting human activity or interests. The species of birds most frequently identified as causing damage by WS State Directors are blackbirds, starlings, cormorants, and Canada geese (Figs. 1-4).

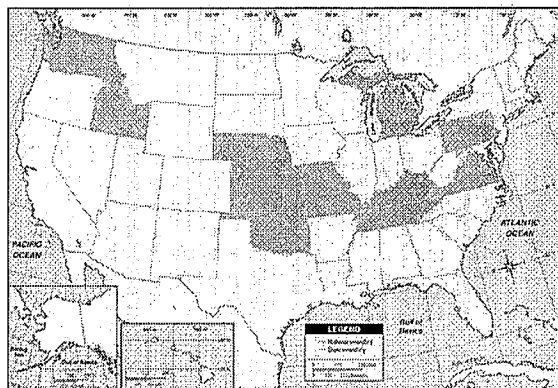


Fig. 1. Wildlife Services State Directors reporting high priority research needs to resolve conflicts with European starlings).

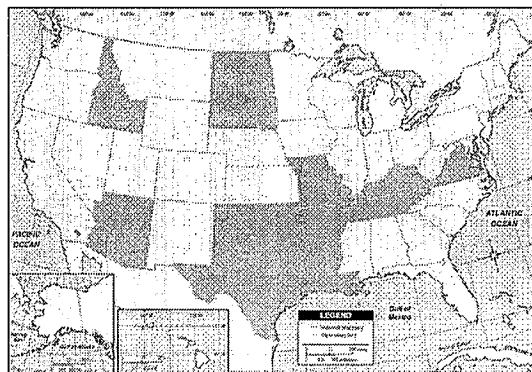


Fig. 2. Wildlife Services State Directors reporting high priority research needs to resolve conflicts with blackbirds.

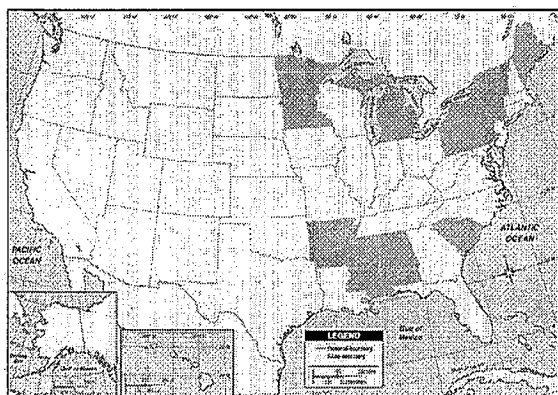


Fig. 3. Wildlife Services State Directors reporting high priority research needs to resolve conflicts with cormorants.

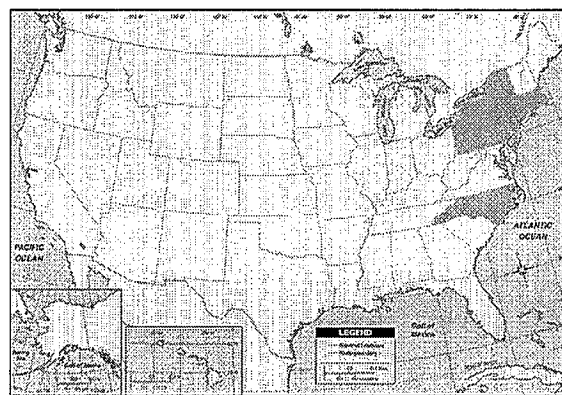


Fig. 4. Wildlife Services State Directors reporting high priority research needs to resolve conflicts with Canada geese.

Starlings (Fig. 1): States reporting problems caused by starlings tend to be within the winter range for this species. Problems frequently reported range from feed loss at dairy operations and beef feedlots; impact of selective feeding by starlings on the protein ration of cattle feed and its negative effect on meat or milk conversion; feed contamination at those operations by bird feces, and; the risk of disease transmission to cattle herds. Other damage areas mentioned included damage to fruit crops, nuisance issues at large urban roosts, property damage through fecal contamination and acid erosion of structures, and possible dissemination of zoonotic diseases.

Blackbirds (Fig. 2): States reporting problems with blackbirds are within the winter and breeding ranges for these species. During the winter, many of the same issues occur as reported for starlings at feedlots and dairies. In addition, blackbirds have significant negative impact on

sunflower seed production during their fall migration. During the early spring, blackbirds have significant impact on rice seeds and seedlings, and in the fall on the headed rice crop. Large blackbird roosts also can have impact on human health (e.g., fecal accumulation and contamination of sites with *Histoplasma* and other pathogens).

Cormorants (Fig. 3): This species is largely a problem in the central and eastern United States. In the southern United States cormorants have significant impact during the fall and winter on catfish production. During the spring and summer the impact of cormorants is on sports fisheries and habitat destruction at breeding colonies. This species has been implicated in transmission of fish diseases and parasites.

Canada geese (Fig. 4): While overabundant non-migratory populations of Canada geese are reported as being a nuisance throughout the United States, this species is primarily at the top of the list of nuisance species on the eastern seaboard. Geese have been implicated in aggressive contacts with humans during the breeding season, habitat destruction, general nuisance, fecal contamination of lawns and ponds, and a possible concern for human health.

Other species of birds were listed by the respondents surveyed, but these species tended to have more local (i.e., individual state) focus (Table 1). Nonetheless, they cause sufficient conflict with human activity to be listed within the top three problem areas by individual WS State Directors.

Table 1. List of bird species or group specifically mentioned by biologists as being involved with human-wildlife conflicts.

	WS State Directors East	WS State Directors West	NWRC Scientists
Blackbirds	✓	✓	✓
Canada geese	✓		✓
Cormorants	✓		✓
Cranes	✓		
Crows	✓	✓	✓
Gulls	✓	✓	✓
Horned larks	✓		✓
House finches			✓
Monk parakeets			✓
Parrots			✓
Pelicans	✓		✓
Pigeons	✓	✓	✓
Robins			✓
Snow buntings	✓		
Starlings	✓	✓	✓
Turkeys	✓		
Vultures	✓		
Wading birds (herons/egrets)	✓		✓

The areas of conflict focus primarily on commodity damage, property damage, nuisance, disease transmission, and human safety. For example, pelicans and wading birds eating bait fish or other aquaculture stock; vultures as depredating livestock or causing property damage; monk parakeets as causing property damage; cranes, parrots, horned larks, robins as eating seedlings or fruits; pigeons, gulls and crows as nuisance species or involved in disease transmission, and various birds involved in risk to aviation safety.

Mammal Species Commonly Reported as Causing Problems: The most frequently cited category of nuisance mammals is predators, including bears, coyotes, mountain lion, and wolves (Fig. 5). Unlike birds, many of these species have different protective status depending upon the specific state. However, the type of conflict is relatively uniform (i.e., depredation of livestock). Interestingly, several eastern states are beginning to report livestock depredation by coyotes and the need to address control methods in a very different environment than found in the western states. The next most frequently cited mammal causing damage is the feral swine. This species is implicated in habitat destruction and disease transmission to domestic swine (e.g., pseudo rabies).

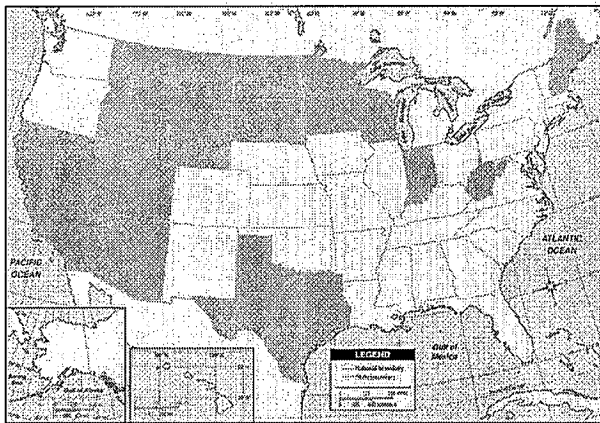


Fig. 5. Wildlife Services State Directors reporting high priority research needs to resolve conflicts with predators: coyotes, wolves, bears, mountain lions.

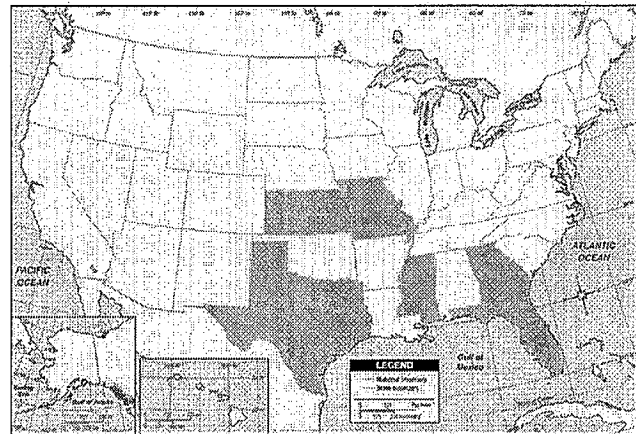


Fig. 6. Wildlife Services State Directors reporting high priority research needs to resolve conflicts with feral swine.

Other species of mammals were cited by State Directors and represent more regional conflicts with wildlife. Armadillos are expanding their geographic range and have been implicated in property damage. Bats are a concern as vectors for zoonotic disease. Bison are a concern as a reservoir and vector for Brucellosis which impacts cattle herd health. Deer cause property damage by browsing horticultural plants, cause natural resource damage by destroying forest structure, are a reservoir for chronic wasting disease and bovine tuberculosis in some states, and are involved in highway collisions. Feral cats have significant impact on native bird populations. Feral dogs can be livestock predators and be a reservoir for canine rabies. Mongoose negatively impact insular bird populations. Nutria are involved in habitat destruction in wetlands. Beaver are implicated in habitat and property destruction. Prairie dogs are a source of cattle injury because of their burrow systems. Raccoons are a reservoir for zoonotic diseases and impact threatened and endangered species. Rodents are reservoirs for zoonotic and animal health diseases, cause property damage, and prey on native bird populations. Skunks are reservoirs for

zoonotic diseases. Others species (e.g. kit foxes and jaguars) are of concern because of management issues complicated by their protected population status.

Table 2. List of mammal species or group specifically mentioned as being involved with human-wildlife conflicts.

	WS State Directors East	WS State Directors West	NWRC Scientists
Armadillo	✓		
Bats		✓	
Bears	✓	✓	✓
Beaver	✓	✓	✓
Bison			✓
Coyotes	✓	✓	✓
Deer	✓		✓
Feral Cats			✓
Feral Dogs			✓
Feral Swine	✓	✓	✓
Jaguars			✓
Kit foxes			✓
Mongoose			✓
Mountain Lion		✓	✓
Nutria		✓	✓
Prairies dogs		✓	
Raccoons	✓		
Rodents	✓		✓
Skunks		✓	
Wild horses			✓
Wolves	✓	✓	✓

Types of Conflict between Humans and Wildlife: The most common areas of wildlife-human conflicts identified by WS personnel are included in Table 3. These are major categories identified by biological professionals, however, it should be noted that the category headings are not mutually exclusive. Rather they reflect different emphasis on frequently overlapping problem areas. There was general agreement between WS operations and research on the rank order of the wildlife conflict areas that needed to be addressed (Fig. 7). The types of commodities affected (not ranked) are reported in Tables 4 and 5.

Table 3. Most frequently reported areas in need of research for human-wildlife conflicts. Ranks were determined by the frequency that a broad research need was cited. The lower the number the more frequently that conflict was cited as needing to be addressed. Similar numbers indicate tied ranks.

	WS Operations	NWRC
Property Protection	1.5	7
Livestock (disease)	1.5	2
Crop Protection	3	1
Livestock (predation)	4	5
Human Health	5.5	8
Safety (transportation)	5.5	9
Natural Resource (habitat)	7	5
Nuisance	8.5	2
Aquaculture	8.5	10.5
Natural Resource (T&E)	10	5
Invasive Species	11	10.5

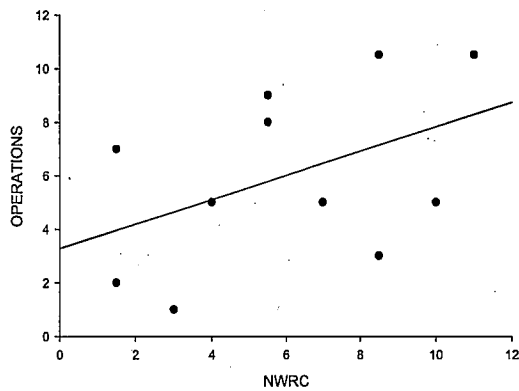


Figure 7. There was a positive rank correlation between WS operations and WS research personnel on the perceived importance of areas of human-wildlife conflict by stakeholders.

Table 4. Types of damage to commodities caused by birds.

	WS State Directors East	WS State Directors West	NWRC Scientists
<i>Ag Commodity (damage/depredation)</i>			
Bait fish			✓
Beef cattle feed loss		✓	
Corn			✓
Cow production loss (weight gain/milk)		✓	
Crawfish	✓		✓
Crops-general	✓		✓
Dairy feed loss		✓	
Fish-aquaculture stock (catfish, etc)	✓		✓

Fish-sports	✓		✓
Fish-salmon	✓		
Fruit crops		✓	
Grain crops			✓
Lettuce			✓
Livestock			✓
Pecans		✓	
Rice-headed	✓		✓
Rice-sprouting	✓		✓
Seedlings			✓
Sunflowers		✓	✓
<u>Animal Health Impacts</u>			
Aquaculture stock disease	✓		
Beef cattle disease		✓	✓
Dairy cow disease	✓	✓	✓
Dairy food contamination	✓	✓	✓
Herd mortality		✓	✓
<u>Human Health Impacts</u>			
Feces-dairy product contamination	✓		
Feces-human pathogen exposure	✓	✓	✓
<u>Natural Resource Damage</u>			
Habitat destruction	✓		✓
Impact on other species	✓		✓
Impact on threatened & endangered species			✓
<u>Nuisance</u>			
Feces-esthetics	✓		✓
Landfills		✓	
Roosts-noise	✓		✓
<u>Property Damage</u>			
Aircraft	✓		
Feces-corrosion (structures/vehicles)	✓		
Structures	✓	✓	✓
<u>Safety</u>			
Aviation	✓		✓
Transportation		✓	

Table 5. List of damage-related issues caused by mammals.

	WS State Directors East	WS State Directors West	NWRC Scientists
<u>Ag Commodity (damage/depredation)</u>			
Beef cattle predation	✓	✓	✓
Crop destruction	✓		
Dairy cattle predation	✓		
Forestry damage/herbivory			✓
Goat predation	✓		
Livestock-predation	✓	✓	✓
Livestock-injury		✓	
Salmon predation	✓		
Sheep predation		✓	
<u>Animal Health Impacts</u>			
Beef cattle disease	✓		✓
Bovine tuberculosis	✓		✓
Herd mortality	✓		
Dairy cow disease	✓		✓
Swine disease		✓	✓
<u>Human Health Impacts</u>			
Zoonoses	✓	✓	✓
<u>Natural Resource Damage</u>			
Antelope (predation)			✓
Big horn sheep (predation)			✓
Deer populations (predation)		✓	
Elk (predation)			✓
Game bird nests (predation)	✓	✓	
Gopher tortoise (predation)	✓		
Habitat destruction	✓		✓
Mule deer (predation)			✓
Sea turtle nests (predation)	✓		✓
Shorebird (predation)	✓		
T&E (predation)		✓	✓
Water quality (fecal contamination)		✓	
<u>Property Damage</u>			
Transportation (roads-flooding by beavers)	✓	✓	
Residential	✓	✓	
Commercial	✓	✓	
<u>Safety</u>			
Aviation	✓	✓	✓
Human attacks (mountain lions, bears)		✓	

Several geographic patterns emerged for research areas identified by WS operational program. The importance of developing research tools to alleviate property damage by wildlife is primarily focused in the eastern United States or other states with higher population densities (Fig. 8).

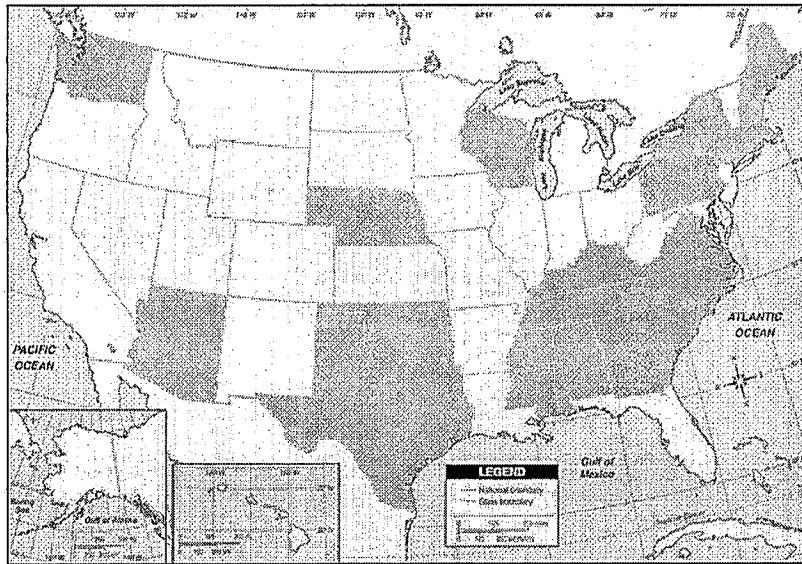


Figure 8. WS State Directors reporting research needs to alleviate property damage caused by wildlife. Note the concentration of reporting in the eastern United States.

Research requests to alleviate disease impacts on domestic animals (Fig. 9) were largely concentrated in states with high production in dairy and beef cattle and concentrated along the migratory and wintering range of starlings and blackbirds.

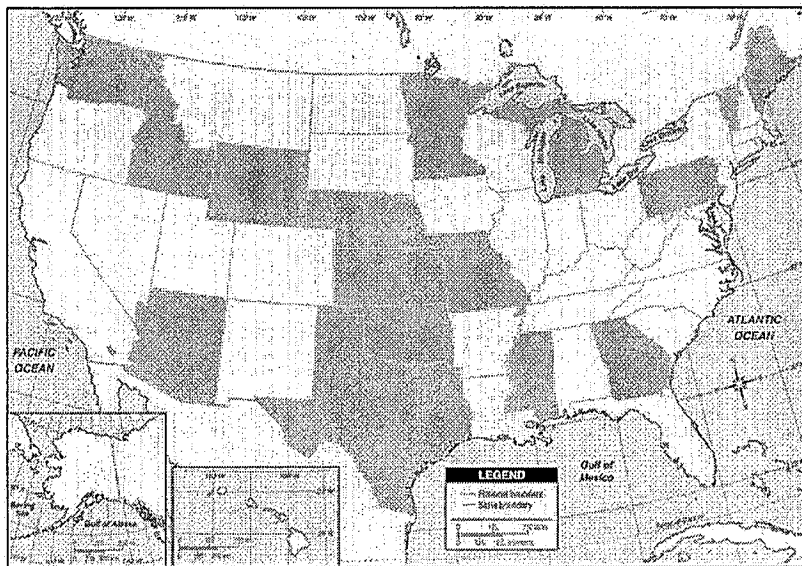


Fig. 9. WS State Directors reporting methods development needs to alleviate livestock losses attributable to disease caused by various wildlife species.

Research requests to alleviate crop damage (Fig. 10) were largely concentrated along the Mississippi flyway, most likely associated with blackbird migration and damage to rice and sunflowers). However, fruit and nut crops were also damaged by other birds.

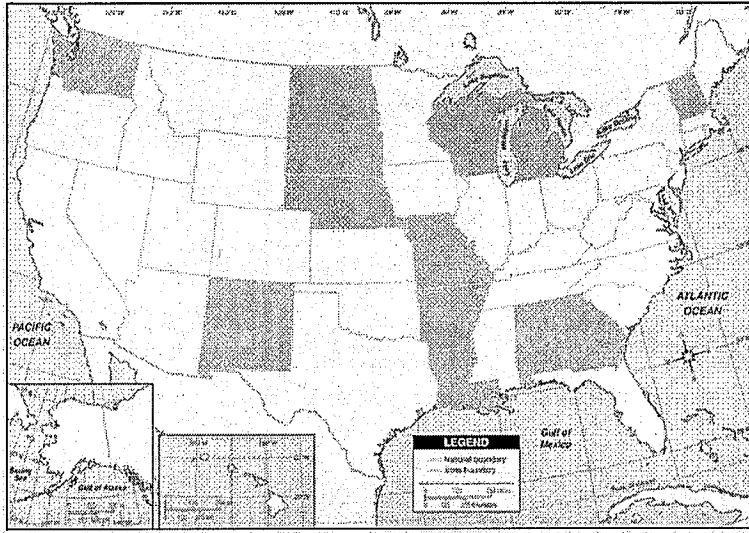


Fig.10. WS State Directors reporting methods development needs to alleviate crop damage caused by various wildlife species.

The top ten sheep producing states are all in the Western Region (TX, CA, WY, CO, MT, SD, UT, ID, OR, and NM). Six of those states listed development of methods to protect livestock from predation as being an important research issue. The top ten beef cattle states occur throughout the country (TX, MO, OK, NE, SD, MT, KS, KY, TN, and FL). Four of those states listed livestock predation as being an important wildlife conflict. The top ten dairy producing states are likewise distributed throughout the country (WI, CA, NY, PA, MN, TX, MI, ID, OH, and WA). Six of those states listed livestock predation as being an important wildlife conflict (Fig. 11).

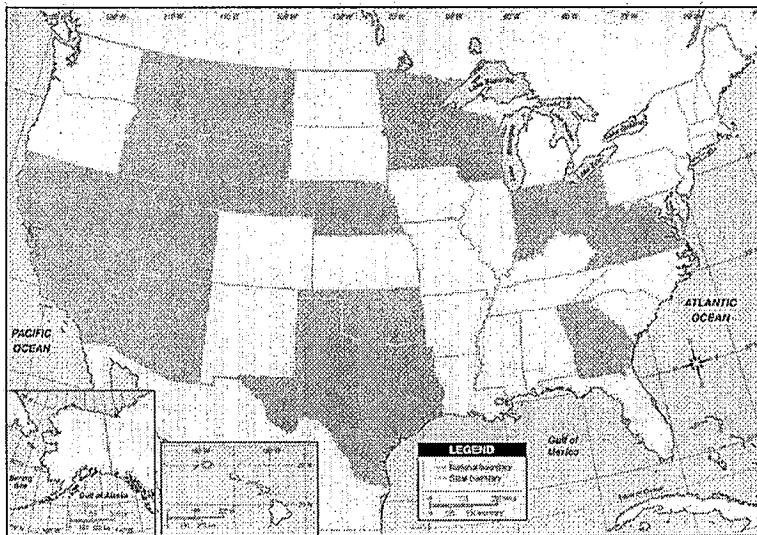


Figure 11. WS State Directors reporting methods development needs to alleviate livestock losses caused by predation.

Detailed summary of areas of wildlife conflict and research needs (alphabetically listed):

- *Aquaculture protection.* Research needs areas include:
 - damage assessments,
 - population estimates of depredating birds,
 - population modeling,
 - development of predation management plans,
 - spatial movement of depredating birds,
 - the role of birds in spreading diseases,
 - estimation of economic impacts of predation on various aquaculture endeavors,
 - impacts of cormorants on vegetation,
 - impacts of cormorants on sports fisheries,
 - development of management tools at the pond side, and
 - strategies for minimizing damage on larger spatial scales (e.g., regional and flyway).

- *Crop protection.* Research areas include:
 - physical and economic damage assessments and impact,
 - evaluation of the efficacy of methods to protect crops,
 - development of repellents,
 - development of hazing devices,
 - development of management plans,
 - registration support, and
 - assessments of the impacts of DRC-1339 on populations of birds.

- *Invasive species.* This category was somewhat intertwined with natural resource protection. Research areas include:
 - estimating damage (ecological and economic) caused by these species,
 - early detection methods,
 - risk assessment,
 - development of control plans, and
 - development of control methods.

- *Human health protection.* The primary research areas identified include:
 - identifying host range in wildlife species of zoonoses,
 - economic impact of zoonoses,
 - development of methods to minimize transmission zoonoses,
 - development of wildlife monitoring and surveillance methods,
 - development of wildlife vaccines,
 - development of baits and lures,
 - understanding wildlife epidemiology and disease ecology, and
 - risk assessment for transmission of zoonotic diseases.

- *Human safety protection.* This area is predominately focused on aviation issues, but surface transportation (vehicle collisions) are also included. Issues focus on:
 - predicting risks (spatial and temporal) wildlife pose for aviation and other modes of transportation,

- habitat and management plans to reduce attractive nuisance hazards, and
 - developing new methods to exclude wildlife from protected areas.
- *Livestock protection (wildlife disease)*. The primary research areas identified include:
 - identifying host range in wildlife species of pathogens impacting domestic animal health and production,
 - economic impact of diseases transmitted by wildlife to domestic production,
 - development of methods to minimize transmission of pathogens from wildlife to domestic animals,
 - development of wildlife monitoring and surveillance methods,
 - development of new diagnostic methods,
 - development of wildlife vaccines,
 - development of baits and lures, and
 - understanding wildlife epidemiology and disease ecology.
 - *Livestock protection (predation management)*: Research is needed to better minimize the impact of predators on livestock production. This includes:
 - gaining information on extent of impact,
 - evaluating control methods,
 - developing new control methods (lethal and nonlethal), and
 - developing management plans.
 - *Natural resource protection (habitat)*: Research is needed to evaluate the impact feral, overabundant native species, or invasive species have on natural resources. Methods are needed to control the populations to minimize their negative impacts on habitats and other wildlife species. Damage assessment (biological and economic) measures were identified as a need. Management plans were identified as a need.
 - *Natural resource protection (T&E)*: Similar to habitat protection, information on feral, native and invasive species' impacts on threatened and endangered wildlife is needed. Methods to control these target species was identified. Evaluation of the risk these target species have on disease transmission to T&E species was requested.
 - *Nuisance abatement*: Documenting the extent of feces, noise, aggressive behavior of problem species were identified as a source of information needed to develop control rationale. Abatement methods (lethal, nonlethal) were identified as research priorities. Most areas identified under this category were located in urban/suburban environments.
 - *Property Protection*: These requests focused on physical damage to property.
 - develop methods to prevent damage to aircraft
 - developing control methods to protect cars and other vehicles
 - develop methods to prevent damage to farm and other equipment
 - develop methods to prevent damage to residential and commercial buildings
 - develop methods to prevent damage to communication and other industrial structures

Methods Development Needs

The WS operational programs were specific in identifying the types of research categories needed to resolve human wildlife conflicts (Fig. 12). Many of the historic methods needs still remain (e.g., toxicants, repellents, lures, baits). However, there was also a need for basic behavioral and ecological information for wildlife that come in contact with humans (e.g., movement patterns, surveillance methods, population modeling as they relate to population management issues or control activities carried out by the operational programs). These requests can be viewed as supporting NEPA documentation requirements and culminate in the high number of requests from operations to research in assistance in developing wildlife management plans as they relate to wildlife damage management scenarios. Other areas of research needs include increasing demand for methods and techniques for wildlife disease sampling and surveillance. There were also requests for economic valuations of state programs and the effectiveness of management tools.

The interpretation of Fig. 12 must be put in context. Some of the methods categories are very broad by their nature, while others focus on technologies. Moreover, the method categories are not mutually exclusive. For example, some respondents may have cited the need for a specific type of toxicant for a specific species. However, program delivery for a toxicant would involve not only development of the toxicant (chemical), but it would also involve other categories not specifically mentioned (e.g., lures to attract the target, baits to deliver the toxicant to the target, development of a delivery system, ecological information for NEPA considerations, and possibly an economic evaluation of need, efficiency, and benefit:cost analysis). Thus, effective methods development and complete operational Program delivery would involve 6 of the 11 methods categories, even though the respondent only listed one method category. Additional research category items such as registration support, prototyping, and technology transfer are also needed for effective and complete program delivery. In summary, although a specific research need is cited, other research and nonresearch investments are needed for complete program delivery to be achieved.

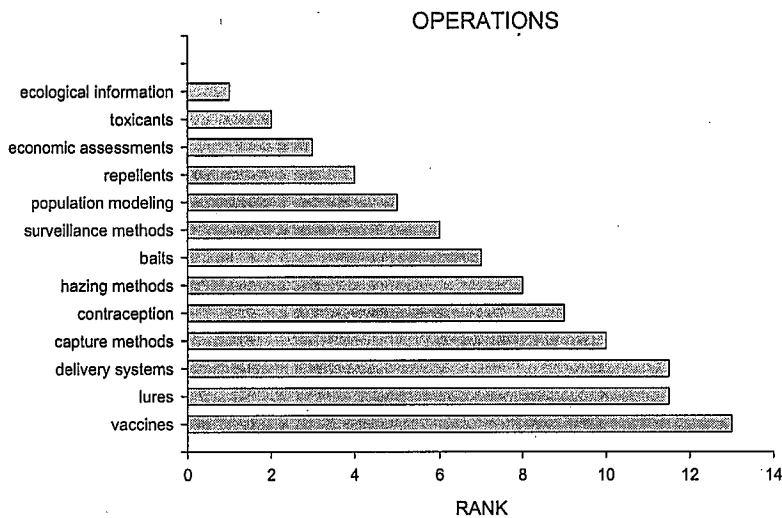


Fig. 12. Most frequently requested types of methods or data cited by WS operational state programs. **Low numbers are ranked higher.**

The types of research methods and information are listed (alphabetically) below:

- *Baits*: Research into what is palatable to various target species for the efficient and effective delivery of vaccines, contraceptives, and toxicants.
- *Capture methods*: Research in this area includes design and testing of mechanical devices, monitors for traps, drugs/stupefactants/tranquilizers/immobilizing agents, and behavioral assessments for success and efficacy.
- *Contraception*: Research includes discovery and development of chemical and immunocontraceptive methods for overabundant target birds and mammals, with emphasis on feral pigs and rodents. This area of research would also include development of strategies and management plans for the successful implementation of these control technologies.
- *Delivery systems*: This area is somewhat overlapping with capture methods and baits. Requests focus on methods to deliver various compounds (vaccines, toxicant, and repellents) to target wildlife. This area of research would include implementation strategies, formulations, devices, and evaluations of efficacy.
- *Economic assessments*: This area of research focuses on documenting and assessing damage caused by wildlife, cost/benefit analysis of methods and management strategies, and operational program evaluation.
- *Ecological information*: The research needs identified under this heading includes gathering basic ecological information on population status and spatial information of species being impacted by control programs. This heading also includes gathering basic behavioral information about target wildlife species that might be useful in developing control and damage abatement methods, as well as devising successful management

plans. One area of focus would be the impact that control technologies and methods might have on the local, regional and larger scale populations of wildlife. This information is needed for NEPA compliance and development of wildlife management plans.

- *Hazing methods*: This area of research focuses on ways to manipulate animal behavior so as to minimize damage caused by wildlife, and disperse concentrations of animals from strategically valuable areas. Requests also included research on the efficacy of these hazing methods in reducing damage, and the impacts the methods have on resource damage in areas nearby the site of hazing. Finally, studies were requested that evaluate the effectiveness and economics of translocation of nuisance wildlife.
- *Lures*: Methods are needed to attract target wildlife to traps or baits (for the delivery of vaccines, contraceptives, and toxicants).
- *Population modeling*: Estimates are needed for target wildlife species to better assess the impact of management and control strategies and plans. This information is increasingly needed for science-based NEPA documentation. This information would also be valuable for determining disease transmission dynamics over spatial and temporal scales.
- *Repellents*: Effective nonlethal methods for crop protection are needed. This area of research includes product discovery, formulation, and registration, as well as development of effective field deployment strategies.
- *Surveillance methods*: Cost effective population disease sampling strategies are needed to assess host range, epidemiology, and disease transmission dynamics in wildlife populations and transmission risks at the wildlife-agricultural-human interface. Also needed are sampling and diagnostic methodologies that are cost effective (minimizing field collection costs and lab analysis costs). Definition of host ranges for a suite of zoonotic and domestic animal diseases is needed.
- *Toxicants*: Effective, registerable toxicants are needed that are target-specific and have low environmental impact. Delivery and formulation are covered under separate headings.
- *Vaccines*: Effective product discovery and efficacy studies are needed for high profile wildlife diseases of high zoonotic and domestic animal health impact potential. Delivery and formulation are covered under separate headings.

Other Stakeholder Input

Several stakeholders responded to the call for research prioritization put out by the Deputy Administrator's office, among them were the Wildlife Management Institute, Association of Fish and Wildlife Agencies, California Fish & Game, and the Animal Welfare Institute.

Among the broader topics listed were research needs on nuisance wildlife issues, predation management, ungulate management, urban predator management, wildlife disease research, human safety, commodity protection, overabundant wildlife population control, nonlethal control strategies and methods, damage assessments, aquaculture, natural resource protection (habitat), human safety (airports, marine safety).

Specific methods research or information mentioned included: evaluation of efficacy of predator control (e.g., DRC 1339) as a predation management tool (ravens), lethal and nonlethal predator control, hazing methods, repellents, impact of nuisance wildlife on economics, and other human activity, population management plans, deer control methods, contraception methods for wildlife, efficacy of relocation programs (effectiveness, impact on survivorship of moved individuals), impact of wildlife diseases on domestic animal production, capture devices, monitoring devices, methods (lethal and nonlethal) to alleviate depredations on aquaculture, rice, and other commodities, measures of impact of invasive species on habitats and other wildlife species, and methods to resolve conflicts between sea lions and boats. In general, the overall requests for assistance parallel requests received from WS operations state directors, and the perception of needs of research scientists.

Specific species and problem associations were identified and research into methods to resolve those conflicts were reported as follows:

- Develop methods to deal with nuisance bears in urban environments
- Sage grouse protection (identify causes of population declines, e.g., disease, predation; and develop management plans to protect populations)
- Develop predation management plans for protection of waterfowl and turkeys
- Develop methods for urban predation management (lions, bears, coyotes)
- Develop methods and strategies to minimize impact of wildlife and zoonotic diseases
- Evaluate efficacy of anti-deer collision devices
- Methods to reduce big game impacts on crops
- Efficacy of fertility control in managing ungulates
- Methods to reduce urban/suburban damage caused by deer
- Develop cheap effective deterrents for deer (repellents, hazing devices)
- Evaluate coyote management strategies in eastern states
- Develop urban deer management plans
- Evaluate damage estimates against producer self reporting estimates
- Evaluate efficacy of bounty systems as a means of damage abatement
- Develop capture devices
- Develop control methods to alleviate aquaculture damage by wildlife
- Evaluate economic impacts of wildlife on aquaculture
- Develop nutria control methods and evaluate impact on natural resource recovery
- Develop blackbird control methods to alleviate impact on rice crops
- Develop nuisance control methods for Canada geese

Summary

The RNA is used as one source of information to guide the WS Methods Development research planning. The RNA, along with Congressional Directives, Deputy Administrator input, input from external sources, and input from stakeholder is used by the National Wildlife Research Center (NWRC) Director to allocate NWRC resources to specific research projects that address the WS Program's research needs through the NWRC's project management system. The systematic summary of the research needs also presents an opportunity for the WS Program to assess spatial and temporal patterns for various types of damages, for the identification of species in conflict with humans, and for identifying methods development needs to address and resolve the human-wildlife conflicts. Finally, with limited resources, the RNA, along with other inputs, allows the WS Program to make critical research management decisions for resource investment that have the broadest economical or strategic impact in finding solutions to human wildlife conflicts.

Acknowledgements

We wish to thank the operational and research WS program personnel for their input into the 2006 RNA. The State Directors and researchers have valuable connections to the spectrum of agricultural and wildlife stakeholders who have direct dealings with wildlife-human conflicts. It is through this interaction of Program personnel with stakeholders that critical research needs are identified. We also thank the Association of Fish and Wildlife Agencies, Wildlife Management Institute, and the National Wildlife Services Advisory Council for providing input from their various stakeholders on the nature and research needs in the area of wildlife-human conflicts.