ARCTIC
VOL. 67, NO. 1 (MARCH 2014) P. 20–27

Invasive Species Management Programs in Alaska: A Survey of Statewide Expenditures, 2007–11

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(*Received 26 November 2012; accepted in revised form 13 May 2013*)

ABSTRACT. Invasive species have already reduced biodiversity, damaged the environment, threatened human health, and created economic losses worldwide. Alaska, by contrast, had relatively few invasive species for most of the 20th century. But increased population and development in recent years have brought an influx of non-native species. However, the problem remains in its infancy, and Alaska still has the opportunity to take advantage of cost-effective management, given appropriate coordination among government agencies and private groups. To help improve such coordination and increase public understanding about this issue, the authors collected data on spending to manage invasive species in Alaska between 2007 and 2011. Such spending increased from $4.7 million in 2007 to $6.9 million in 2010, and it totaled $29 million over the entire study period. Federal agencies paid 84% of that total, non-profits paid 9%, the State of Alaska paid 5%, local governments paid 2%, and private donors paid less than 1%. Most spending (79%) targeted invasive terrestrial plants and animals, but spending for invasive marine and freshwater organisms increased over the period. The largest individual expenses were for eradicating Norway rats that were killing bird populations on an Aleutian island ($5 million), northern pike that were eating juvenile salmon in lakes of Southcentral Alaska ($2.7 million), and European rabbits that were destroying bird habitat in southwestern Alaska ($0.8 million). Overall, research accounted for 24%, monitoring for 20%, eradication for 20%, administration and planning for 11%, and other spending for 25% of total expenditures. The number of jobs in managing invasive species increased over the study period, as did volunteer efforts, which may suggest increasing public awareness about this issue in Alaska.

Key words: invasive species, Alaska, expenditure survey, resource management, ecological economics

RÉSUMÉ. Les espèces envahissantes ont déjà eu pour effet de réduire la biodiversité, de nuire à l'environnement, de menacer la santé de l'être humain et d'engendrer des pertes économiques partout dans le monde. Malgré tout, pendant la quasi-totalité du XX^{e} siècle, relativement peu d'espèces envahissantes ont atteint l'Alaska. Cela dit, l'augmentation de la population et les travaux d'aménagement qui ont eu cours dans la région ces dernières années ont apporté une panoplie de plantes non indigènes. Cependant, puisque le problème n'en est qu'à ses débuts, il n'est pas trop tard pour l'Alaska de profiter d'une gestion économique qui serait le fruit d'une coordination adéquate entre les organismes gouvernementaux et des groupes privés. Afin de faciliter cette coordination et d'aider les gens à mieux comprendre cet enjeu, les auteurs ont recueilli des données sur les sommes affectées à la gestion des espèces envahissantes en Alaska entre 2007 et 2011. Ces dépenses sont passées de 4,7 millions de dollars en 2007 à 6,9 millions de dollars en 2010. Pendant toute la période visée par l'étude, elles ont totalisé 29 millions de dollars. Les organismes fédéraux ont affecté 84 % de cette somme et les organismes sans but lucratif ont affecté 9 % du total, tandis que l'État de l'Alaska a versé 5 % du total, les gouvernements locaux, 2%, et des particuliers, moins de 1 %. La plus grande partie des fonds affectés à la lutte des espèces envahissantes (79 %) visait les plantes et les animaux terrestres, bien que les fonds injectés dans la lutte des espèces marines et des organismes envahissants d'eau douce aient augmenté pendant la période. Les dépenses les plus importantes visaient l'éradication des rats de Norvège qui tuaient les populations d'oiseaux sur une île aléoutienne (5 millions de dollars), du brochet du Nord qui mangeait le saumon juvénile des lacs du centre-sud de l'Alaska (2,7 millions de dollars), et des lapins d'Europe qui détruisaient l'habitat de la faune avienne dans le sud-ouest de l'Alaska (0,8 million de dollars). Dans l'ensemble, les dépenses se sont réparties comme suit : 24 % pour les travaux de recherche, 20 % pour la surveillance, 20 % pour l'éradication, 11 % pour l'administration et la planification, et 25 % pour des dépenses diverses. Au cours de la période visée par l'étude, le nombre d'emplois consacré à la lutte des espèces envahissantes s'est accru, comme cela a été le cas du travail accompli par des bénévoles, ce qui laisse entendre que le grand public est de plus en plus conscient de cet enjeu en Alaska.

Mots clés : espèces envahissantes, Alaska, enquête sur les dépenses, gestion des ressources, écolo-économie

Traduit pour la revue *Arctic* par Nicole Giguère.

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http://dx.doi.org/10.14430/arctic4359
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INTRODUCTION

Non-native species are those that people introduce into an area, either intentionally or unintentionally. Not all non-native species are invasive, and many of them in fact benefit people. For example, non-native crops and non-native livestock are the backbone of the U.S. agriculture industry, and they are important parts of the horticulture, ornamental plant, aquarium, and pet markets.

Invasive species, by contrast, are those non-native species that establish themselves, dominate their new habitats, and are likely to cause economic loss, environmental damage, or harm to human health (Federal Register, 1999). They can harm water supplies, reduce biodiversity by crowding out native plants, or lead to losses in agriculture and aquaculture production, to name a few of their potential effects. Such species are a growing threat worldwide: more and more are being introduced, partly as a result of growing human populations and increasing global trade, commerce, and development (Pimentel et al., 2005).

Managing invasive species can be an economic and policy issue, and it often has less to do with biology and ecology than many people may think (Perrings et al., 2002). Economics can help people understand what drives the invasive species problem, what new institutions might be needed to deal with it, and what kinds of costs invasive species create, as well as inform decision makers about the benefits of management actions. Cost studies can measure what society pays because of invasive species—for example, losses in power generation when an invasive species reduces the efficiency of power-generation equipment.

Yet despite the economic costs that invasive species are known to create, there are no comprehensive studies that estimate all costs to society for all invasive species in the United States. A few studies have attempted to quantify some costs of invasive species. In 1993, the Office of Technology Assessment, which was an office of the U.S. Congress from 1972 until it was closed in 1995, estimated the economic losses created by 79 invasive species between 1906 and 1991 (U.S. Congress, 1993). In 2012 dollars, the estimated losses over that 85-year period amounted to about $160 billion. Pimentel et al. (2005) estimated that the annual economic cost of some of the approximately 50 000 invasive species nationwide, in 2012 dollars, amounted to at least $137 billion, equal to about 1% of the U.S. gross domestic product.

The federal government has been the major source of funds for managing invasive species. The General Accounting Office reported that in 2000 the federal government spent $824 million to fight invasive species. Most of that money—about 88%—came from the U.S. Department of Agriculture, and more than half was used to prevent invasive species from spreading (U.S. GAO, 2000).

State governments in general have spent much smaller amounts to manage invasive species, but spending levels vary considerably by state and year. For example, in 2000 California spent $127 million and Florida $87.2 million to combat invasive species, while Hawaii spent $10 million, Idaho spent $5 million, and Maryland spent $2.8 million (U.S. GAO, 2000). In 2008, state agencies in Oregon spent $5.2 million for projects related to invasive species (Creative Resource Strategies, 2010).

Economic Effects of Invasive Species in Alaska

Alaska is not immune to invasive species, but the problem is still in the early stages (Fig. 1). According to Carlson and Shephard (2007), the current infestation levels in Alaska are comparable to levels in the Lower 48 roughly 60 to 100 years ago.

At this point, Alaskans have the opportunity to take preventive, early detection, and rapid response actions well before invasions reach thresholds at which eradication and control efforts become very expensive. The earlier invasions are managed, and the smaller the initial infested areas, the higher the chances for successful eradication (Rejmánek and Pitcairn, 2002). Current and future investments in managing invasive species conserve market and non-market values that people derive from healthy Alaska ecosystems (Colt, 2001).

Our study is the first to look at some of the economic effects of invasive species in Alaska. It estimates public and private spending from 2007 through 2011 to manage invasive species in the state, as well as jobs and payroll associated with managing those species. This research is intended to help improve coordination among government agencies and private organizations working to control invasive species in Alaska and to increase public understanding about this issue. It serves as a foundation for further study of management cost efficiencies and the evaluation of program effectiveness, which were beyond the scope of this research.

METHODS

To get a reasonably complete picture of investment in invasive species control in Alaska, we surveyed federal, state, local, tribal, non-profit, and private agencies and organizations involved in managing such species, using an e-mailed questionnaire. We pretested and refined the questionnaire in collaboration with representatives of federal and state agencies who in 2011 attended the Alaska Invasive Species Conference, which each year brings together people responsible for or interested in managing invasive species in the state. We developed an e-mail questionnaire that was flexible enough to accommodate different accounting practices across federal and state agencies and other organizations.

Specifically, we asked agencies and organizations for information about total spending on invasive species from 2007 to 2011—employment, personnel cost, hourly effort, expenditures on equipment and supplies—as well as a description of sources and recipients of funds and efforts by volunteers. We also asked respondents to provide detailed

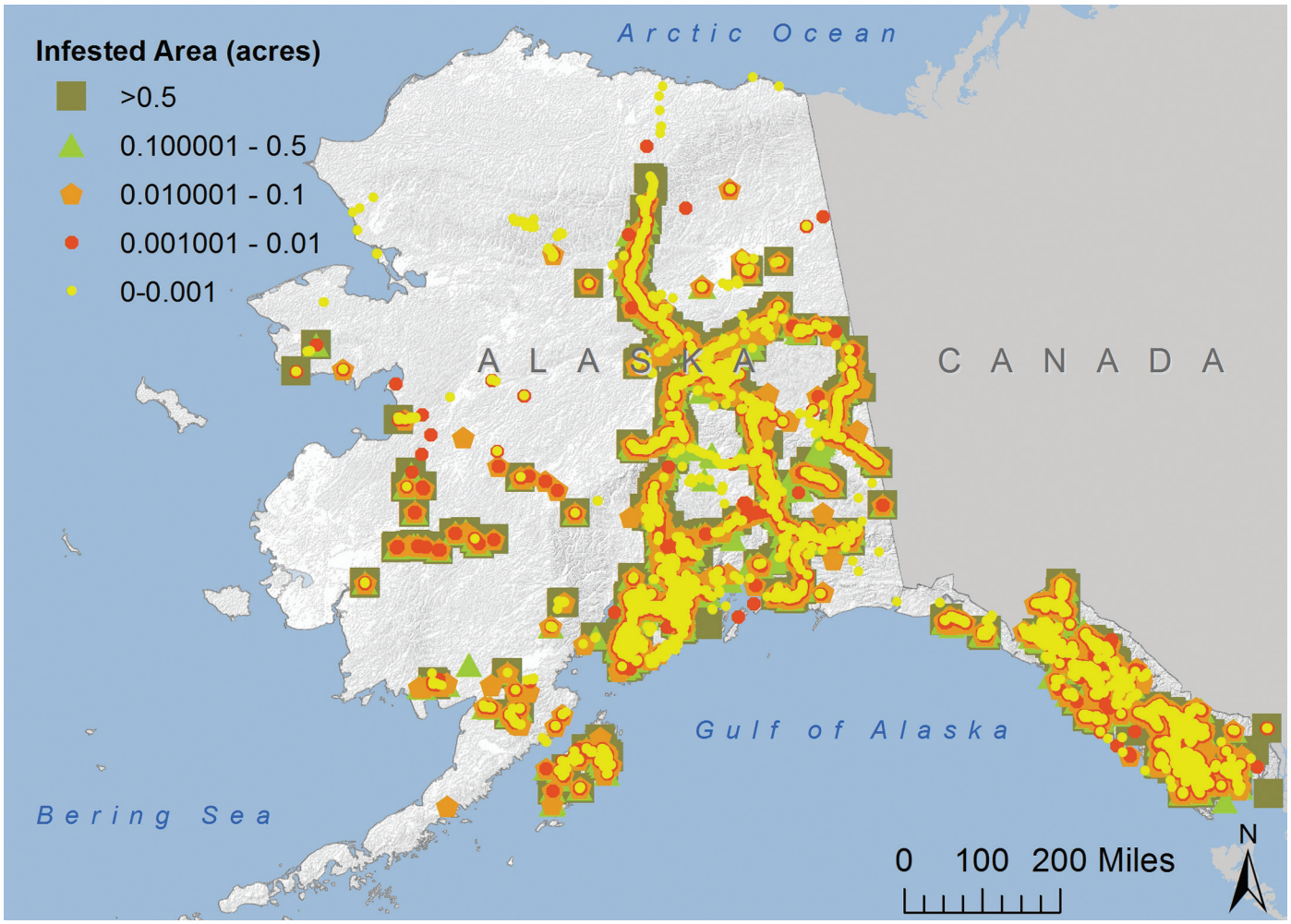


FIG. 1. Map showing known locations of non-native plants in Alaska as of 2011, from the Alaska Exotic Plant Information Clearing House at the University of Alaska Anchorage (AKEPIC, 2012). Most known infestations occur along Alaska's road system, near population centers, and in Southeast Alaska.

information by species targeted, action taken, location, and areal extent of the action.

The difficulty in gathering historical data is that some agencies and organizations were unable to obtain data for certain projects or did not have detailed budget-tracking systems in place. If respondents didn't know how much their organizations spent, we asked them to provide a best estimate. Also, for some agencies and organizations, a single contact could provide all the spending information, but for others we had to contact several people to get all the information we needed. And if only half the contacts at a particular agency responded, it does not imply half the funds were accounted for; the people who did not respond might have had information about more or less than half the money spent. Even if we knew that additional funds had not been accounted for, we included only the funds reported, thus providing a conservative estimate.

Because a complex web of federal, state, local, tribal, and non-profit organizations is involved, we paid particular attention to where the money was coming from and where it was finally spent. The path between could involve several pass-through organizations. For example, federal agencies are major funding sources for non-profit groups and state agencies, but they also actively manage invasive species themselves. By cross-checking who put up the money and who spent it, we minimized double counting of funds.

Starting with a list of 112 agency contacts, we collected information from 84 people, for a response rate of 75%. We contacted 63 organizations: 11 federal, 8 state, 20 non-profits, 7 private, and 6 tribal organizations, 7 university departments, and 4 local governments. The Alaska Railroad Corporation was the largest entity that did not respond to our data request. Our own research found that the railroad's budget for vegetation control ranged from $400 000 in 2007 to $983 000 in 2011. The railroad's vegetation control program focuses largely on removing vegetation along tracks, which is primarily native vegetation, although it is likely to include an unknown amount of invasive species. We therefore ignore the railroad's budget for our analysis, which produced a small overall margin of error for our study.

Not all organizations were able to provide the information in the format we requested. For agencies and organizations with varying fiscal years, we recorded data based on each organization's fiscal year; slight differences in

TABLE 1. Funding for invasive species management in Alaska (2007 – 11), by source.

	2007	2008	2009	2010	2011	mean	%
Federal	$4 264 000	$5 973 000	$4 252 000	$5 441 000	$4 385 000	$4 863 000	84%
Non-profit	$336 000	$346 000	$466 000	$697 000	$682 000	$505 000	9%
State	$82 000	$112 000	$407 000	$614 000	$327 000	$308 000	5%
Local	$25 000	$127 000	$126 000	$114 000	$121 000	$103 000	2%
Private	$13 000	$13 000	$55 000	$26 000	$30 000	$27 000	< 1%
Total	$4 720 000	$6 571 000	$5 306 000	$6 892 000	$5 545 000	$5 806 000	100%

fiscal years average out over the five years for which we collected data. In cases where respondents didn't know all the initial funding organizations and their individual funding amounts, we divided the total budget equally among the known multiple sources.

To calculate the number of jobs associated with managing invasive species in Alaska, we estimated full-time equivalent employment. For part-time workers, the full-time equivalent was calculated by dividing the total hourly effort of part-time work reported by eight hours. The total number of jobs then equals the full-time equivalent of part-time work plus the full-time positions reported. We dealt with lump sum amounts for multiple actions, or types of expenses across multiple years or across categories, by dividing the total lump sum amount reported by the number of actions, years, or categories (assuming equal amounts per action, year, or category of expense). Some agencies added a category for travel expenses, which was not part of our data request.

To estimate the volunteer hours people spent managing invasive species, we either stated the hours as reported by respondents or attributed them on the basis of an eight-hour workday and the volunteer days and number of volunteers reported. Finally, we made several follow-up phone calls to each contact between November 2011 and March 2012.

The values presented in the tables are rounded and adjusted to ensure consistent totals across tables. We do not want to give a false impression of accuracy but rather to convey the magnitude of spending and proportions across categories.

RESULTS AND DISCUSSION

Funding Sources and Implementing Agencies

Over the period 2007 to 2011, spending for managing invasive species in Alaska totaled $29 million, and annual spending varied from $4.7 million in 2007 to $6.9 million in 2010 (Table 1). Annual average spending during the study period was $5.8 million, of which the federal government contributed $4.9 million, non-profit organizations more than $500 000, the state government roughly $300 000, and local governments about $100 000. Overall from 2007 through 2011, the federal government supplied 84% of all the money spent to manage invasive species, with non-profits putting up 9%, state sources contributed 5%, and local government and private donors supplied 2%.

The top two funding organizations for dealing with invasive species in Alaska during the study period were the U.S. Fish and Wildlife Service ($1.6 million annually) and the U.S. Department of Agriculture ($1.5 million annually). Those two federal agencies provided almost half the total funding for managing invasive species in the state between 2007 and 2011. The National Oceanic and Atmospheric Administration (NOAA)—through the Alaska Sustainable Salmon Fund—provided almost $400 000 annually. That money was then distributed among state, local, tribal, and non-profit organizations.

Another way federal money paid for managing invasive species during the study period was through the 2009 American Reinvestment and Recovery Act. In 2009, the Alaska Association of Conservation Districts entered into a cooperative agreement with the U.S. Forest Service to accept $1.14 million of Recovery Act money to implement the Alaska Invasive Plants Project, intended to oversee and coordinate invasive plant programs via coordinators stationed in Soil and Water Conservation Districts throughout the state. The coordinators conducted invasive plant surveys in their regions, as well as control, education, and outreach projects. In addition, the Alaska Natural Heritage Program employed the Alaska Invasiveness Ranking System, a tool to prioritize invasive species management.

Over the past five years, federal agencies were not only the main funding source for other entities, but also the main entities taking management actions themselves, with annual operating budgets for managing invasive species totaling more than $2.4 million annually (Fig. 2).

From 2007 through 2011, 79% of all funding went for managing invasive species in terrestrial ecosystems, 14% for species in freshwater ecosystems, and 8% for species in marine ecosystems (Table 2). The annual distribution of funds among invasive species in marine, freshwater, and terrestrial ecosystems changed somewhat over the period, with more funds spent on marine and freshwater species in recent years.

Most Expensive Species

Among the most costly management actions in Alaska in the five-year study period was the eradication of several species: Norway rats (*Rattus norvegicus*) on an Aleutian Island; northern pike (*Esox lucius*) in Southcentral lakes; and European rabbits in southwestern Alaska (*Oryctolagus cuniculus*). Monitoring European green crab (*Carcinus maenas*) approaching the southeast coast was also among the top expenses.

TABLE 2. Funding for invasive species management in Alaska (2007 – 11), by species.

	2007	2008	2009	2010	2011	mean	%
Terrestrial plants	$1 712 000	$1 858 000	$2 041 000	$3 521 000	$2 710 000	$2 368 400	41%
Terrestrial animals	$2 272 000	$3 635 000	$1 932 000	$1 988 000	$1 144 000	$2 194 200	38%
Freshwater fish	$421 000	$553 000	$878 000	$825 000	$716 000	$678 600	12%
Marine	$248 000	$451 000	$373 000	$487 000	$800 000	$471 800	8%
Freshwater plants	$67 000	$74 000	$82 000	$71 000	$175 000	$93 800	< 2%
Total	$4 720 000	$6 571 000	$5 306 000	$6 892 000	$5 545 000	$5 806 000	100%

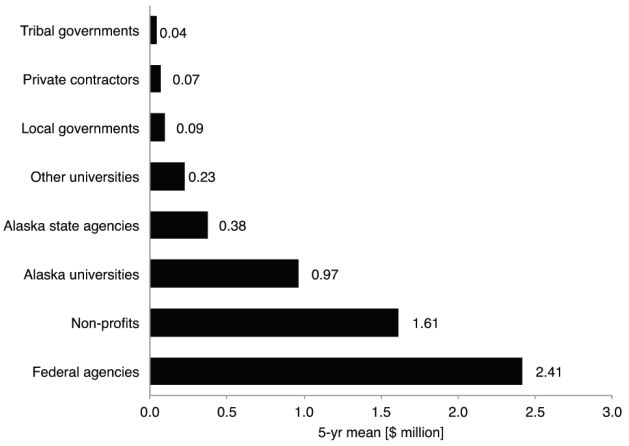


FIG. 2. Mean annual expenditure in 2007 – 11 (millions of dollars) for actions against invasive species in Alaska of the various agencies that fund and implement such actions.

The rats were introduced by a shipwreck decades ago on an island in the Aleutians that became known as Rat Island. The rats destroyed local bird populations, and getting rid of them cost more than $5 million during the study period. More than 50% of the funds were used to eradicate the rats and 33% for follow-up monitoring. The efforts succeeded, and the former "Rat Island" is once again known by its original Aleut name, *Hawadax*.

Local anglers introduced northern pike into lakes and streams in Southcentral Alaska, where they are considered a non-native species. Northern pike are native to some parts of Alaska, but they hurt local trout and salmon populations in Southcentral Alaska by eating large numbers of juvenile fish. Management efforts required $2.8 million between 2007 and 2011, of which 67% was spent for monitoring and 12% for control. Almost all (96%) of the $0.8 million spent for managing European rabbits was for eradicating them.

About $0.7 million was spent to monitor the European green crab during the study period. This species has been observed moving toward Alaska's southeast coast, where it could threaten Dungeness and other native crabs. Commercial fisheries are an important part of Alaska's economy, and the threat of the European green crab and other invasive marine species may warrant more spending to manage them as time goes on (Hines et al., 2004).

Invasive terrestrial plant species that required costly management during the study period included white sweetclover (*Melilotus albus*), Japanese knotweed (*Polygonum cuspidatum*), Bohemian knotweed (*Polygonum bohemicum*), and giant knotweed (*Polygonum sachalinense*), with expenses for those species totaling $0.5 million. Another $0.4 million went for managing reed canarygrass (*Phalaris arundinacea*). Beekeepers intentionally introduced white sweetclover to Alaska to enhance honey production. But the plant is known to alter soil conditions and pollination patterns and to degrade natural grassland communities (Klein, 2011). More than 71% of the spending for white sweetclover went toward research and control measures to keep established invasions from spreading and new invasions from spreading farther. Knotweed and reed canarygrass clog waterways and harm local populations of salmon and other aquatic species. For both those species, more than 80% of spending was used to eradicate them. The proportion of funds spent on freshwater plants increased during the study period because of recent discoveries of Western waterweed (*Elodea nuttallii*) in several locations in Alaska.

Types of Management

Statewide, most spending for invasive species during the study period went for intervention—which includes efforts to eradicate, control, prevent, and contain—and for research and monitoring (Table 3).

The largest single expenditure—about one-quarter of all invasive species funding—was for research. Research spending amounted to approximately $1.4 million annually, ranging from $1.2 million in 2007 to $1.6 million in 2008 (Table 3).

Monitoring efforts and eradication were the next largest individual expenses, each accounting for approximately $1.2 million (20%) annually. Monitoring expenses climbed from $0.5 million in 2008 to almost $1.6 million in 2009, but dropped to about $1.0 million in 2011. Eradication expenses varied from year to year, from a low of $202 000 in 2007 to a high of $3 261 000 in 2008, when more than $2.5 million (one-fifth of total 2008 funding) was spent to eradicate Norway rats.

Administrative and planning expenses were smaller, varying from about $280 000 to $800 000 annually, or 11% to 17% of total spending for invasive species. Administrative expenses stabilized at approximately $700 000 annually in the last years of the study period. The administrative costs of obtaining permits for management actions accounted for about 1% of the total funding annually.

Education and outreach funding increased over the study period, from $290 000 (7% of available funds) in 2009 to

TABLE 3. Allocation of funding related to invasive species management in Alaska (2007 – 11), by management action.

	2007	2008	2009	2010	2011	mean	%
Research	$1 232 000	$1 563 000	$1 386 000	$1 398 000	$1 323 000	$1 380 000	24%
Monitoring	$1 470 000	$498 000	$1 569 000	$1 241 000	$1 081 000	$1 172 000	20%
Eradication	$202 000	$3 261 000	$611 000	$1 076 000	$663 000	$1 163 000	20%
Admin./Planning	$796 000	$279 000	$628 000	$765 000	$718 000	$637 000	11%
Outreach	$350 000	$452 000	$290 000	$776 000	$718 000	$517 000	9%
Control	$197 000	$323 000	$318 000	$268 000	$649 000	$351 000	6%
Prevention	$57 000	$73 000	$134 000	$199 000	$235 000	$139 000	2%
Containment	$293 000	$39 000	$73 000	$114 000	$68 000	$117 000	2%
Restoration	$26 000	$33 000	$53 000	$78 000	$65 000	$51 000	1%
Permits	$37 000	$31 000	$44 000	$77 000	$23 000	$42 000	1%
Training	$24 000			$12 000		$8 000	0%
Other	$36 000	$19 000	$200 000	$888 000	$2 000	$229 000	4%
Total	$4 720 000	$6 571 000	$5 306 000	$6 892 000	$5 545 000	$5 806 000	100%

more than $700 000 (13% of available funds) in 2010 and 2011. Funding for efforts to prevent the spread of invasive species showed the same pattern, increasing from $57 000 in 2007 to more than $235 000 in 2011. Fostering public awareness about invasive species by increasing spending on prevention, education, and outreach will be helpful in the fight against invasive species in Alaska, if such spending continues in the future.

All other types of intervention combined (prevention, containment, control, and restoration) accounted for approximately 13% of annual spending. Control measures (to keep established invasions from spreading) cost more than $350 000 annually during the study period; prevention measures (efforts to stop species from being introduced into Alaska) used $139 000 each year; and containment measures (attempts to stop new invasions from spreading) cost $117 000 per year. Restoration (returning ecosystems to their initial state after invasive species have been removed) cost $50 000 annually, or 1% of total spending.

Management Budgets, Jobs, Payroll, and Volunteer Efforts

We also collected data on operating budgets, the number of jobs, and the payroll associated with invasive species work from 2007 through 2011. The organizations with the largest annual operating budgets for managing invasive species were the U.S. Fish and Wildlife Service ($1.1 million), the U.S. Department of Agriculture ($1.0 million), The Nature Conservancy ($0.4 million), and the Alaska Department of Fish and Game ($0.4 million).

The number of jobs associated with managing invasive species in Alaska increased from an estimated 31 full-time equivalent jobs in 2007 to more than 70 in 2010 and 2011. These jobs are mostly in Alaska, but they include a few research positions outside the state. The total payroll for these jobs was $1.4 million in 2007, $1.6 million in 2008, $2.1 million in 2009, $3 million in 2010, and $2.8 million in 2011. That was an annual average of $2.5 million and a total of almost $11 million during the study period.

On average from 2007 to 2011, the U.S. Fish and Wildlife Service had an estimated 33 part-time jobs and one full-time job dedicated to invasive species work, while the Alaska Department of Fish and Game had 15 part-time jobs and one full-time job. The U.S. Department of Agriculture had 10 full-time jobs, but those lost funding in 2012. The Smithsonian Environmental Research Center had 10 part-time jobs for managing invasive species during the study period.

Annual payroll associated with managing invasive species in Alaska from 2007 to 2011 was $506 000 at the Department of Agriculture; $288 000 at the University of Alaska Anchorage's Alaska Natural Heritage Program; $207 000 at the Fish and Wildlife Service; $190 000 at the National Park Service; and $178 000 at the Department of Fish and Game.

It's important to keep in mind that many of the jobs described above were funded by federal grants and therefore are not permanent.

Agencies we surveyed also reported spending for machinery to fight invasive species, ranging from $202 000 to $1 million annually during the study period, with an annual average of $440 000. Spending for other equipment besides machinery and general supplies ranged between $429 000 and $872 000 per year, for an annual average of $688 000.

Finally, volunteers made it possible to carry out many of the projects to manage invasive species in Alaska during the study period. One example is a National Park Service (NPS) program that annually employed crews of seven to nine students (at nominal pay considered volunteers by the NPS), recruited through programs at AmeriCorps or the Student Conservation Association. These students provided supervision, transportation, equipment, and logistic support for volunteer crews pulling invasive weeds in national parks. And it was volunteers in a community-based monitoring program in Sitka who discovered one of the most dangerous of Alaska's known marine invasive species, the glove leather tunicate (*Didemnum vexillum*). This rapidly growing fouling species forms dense mats over other benthic marine life, particularly threatening shellfish fisheries.

The number of volunteers involved in fighting invasive species in Alaska increased sharply during the study period, from around 200 in 2007 and 2008 to more than 3000 in 2011. We estimate that average annual volunteer

TABLE 4. Funding for invasive species management in Alaska (2007 – 11), by region.

	2007	2008	2009	2010	2011	mean	%
Southcentral	$886 000	$1 278 000	$1 516 000	$1 980 000	$2 265 000	$1 585 000	27%
Southwest	$1 443 000	$2 624 000	$912 000	$866 000	$141 000	$1 197 000	21%
Interior	$510 000	$703 000	$821 000	$688 000	$277 000	$600 000	10%
Southeast	$98 000	$305 000	$352 000	$379 000	$606 000	$348 000	6%
North			$4 000	$50 000	$2 000	$11 000	0%
Statewide	$1 689 000	$1 648 000	$1 633 000	$2 148 000	$2 243 000	$1 873 000	32%
Other	$94 000	$13 000	$67 000	$781 000	$11 000	$192 000	3%
Total	$4 720 000	$6 571 000	$5 306 000	$6 892 000	$5 545 000	$5 806 000	100%

hours ranged between 5000 and 7000. Much of the increase can be traced to the American Recovery and Reinvestment Act, which temporarily made funds available for invasive species projects. That money has now all been used. But responses we got to our survey indicate that volunteerism is increasing—a sign that public involvement and awareness about invasive species may be on the rise in Alaska.

Regional Distribution of Spending

We also used our survey results to analyze the geographic distribution of spending to manage invasive species in Alaska (Table 4). We divided Alaska into five regions, North, Interior, Southcentral, Southwest, and Southeast. We found that the allocation of spending varied by region and by year during the period from 2007 through 2011.

Overall during the study period, Southcentral Alaska, where much of the Alaska population lives and where invasive species are most widespread, had the most spending (27%), followed by Southwest Alaska (21%) and Interior Alaska (10%). Southwest Alaska is more sparsely populated, but several projects in the Alaska Maritime National Wildlife Refuge and other areas of Southwest Alaska targeted specific species considered invasive in that region, including Norway rats, European rabbits, feral horses, hoary marmots, and caribou. Spending in that region dropped in 2011 (Table 4), after eradication projects in the Alaska Maritime National Wildlife Refuge were completed.

In the later years of the study period, spending to manage invasive species increasingly focused on Southcentral Alaska, where almost half (47%) of total funding during the study period was used to eradicate northern pike, one of the primary invasive species in Southcentral Alaska that threatens trout and salmon populations in Upper Cook Inlet and its tributary systems. That work was primarily paid for by the U.S. Fish and Wildlife Service and the Alaska Sustainable Salmon Fund, with money provided by NOAA. The other half of overall spending during the study period ($2.8 million) was used in Southcentral Alaska to fight invasive terrestrial plants like orange hawkweed (*Hieracium aurantiacum*), reed canarygrass, white sweetclover, European bird cherry (*Prunus padus*), and Canada thistle (*Cirsium arvense*). Funds for managing invasive terrestrial plants came from a variety of federal, state, and private-sector sources, and the biggest share of spending went to eradicating or managing established invasions.

The Interior, Southeast, and North regions of Alaska saw substantially less spending than the Southwest and Southcentral regions from 2007 through 2011 (Table 4). In Interior Alaska, spending was concentrated on terrestrial plants like white sweetclover and European bird vetch (*Vicia cracca*). Resource managers also paid increasing attention to the Western waterweed, known to occur in Fairbanks, Anchorage, Cordova, and the Kenai Peninsula.

In Southeast Alaska, spending during the study period focused on marine invasive species because of that region's proximity to British Columbia, where many marine invasive species are already established. Community-based monitoring activities paid off in 2010, when a volunteer organization detected the glove leather tunicate in Sitka, a discovery that resulted in an increase in spending on invasive marine species. In addition, giant hogweed (*Heracleum mantegazzianum*) was successfully eradicated. Stands of knotweed, orange hawkweed, and Canada thistle were removed, but those invasive weeds have not yet been eradicated. In northern Alaska, activities during the study period included monitoring of and research on invasive terrestrial plants along the Dalton Highway, which represents the primary pathway by which invasive species reach Arctic regions of Alaska.

A portion of spending for managing invasive species during the study period—more than $1.9 million per year—was used statewide and not for a particular region (Table 4). Much of that funding was for the Department of Agriculture's Agricultural Research Station in Fairbanks, which closed in 2012 as a result of federal budget cuts. When the station was operating, its research informed the U.S. Forest Service, the Bureau of Land Management, and other agencies about how to control invasive plants in Alaska. It also studied the effects of invasive species on native ecosystems, operated the only cold-climate seed bank in Alaska, and conducted research on food security.

CONCLUSION

These findings provide a broad picture of spending associated with invasive species in Alaska from 2007 through 2011. During that period, spending ranged from $4.7 million to $6.9 million annually, with the federal government supplying 84% of the money and the state government only 5%—$308 000 annually, or about 0.003% of the state

budget. The relatively low overall level of spending, particularly spending by the State of Alaska, reflects the fact that the problem of invasive species is still in its infancy in Alaska.

But even though invasive species aren't as common here as in other parts of the country, their numbers are growing and they are spreading farther. Our survey results indicate that the state government should take a bigger role in fighting the problem, particularly in the face of federal budget cuts. Alaska still has the opportunity to use cost-effective solutions like education, outreach, prevention, and early detection and rapid response, rather than letting the problem grow until solutions are much more expensive and difficult to carry out.

We found a complex web of public and private organizations that are currently working to combat invasive species in Alaska. Coordinating the limited resources available to manage this growing problem will become more critical in the future. It may be time for Alaska to manage invasive species more efficiently by creating a new agency that could coordinate all the efforts. The legislature has considered creating a formal Alaska Invasive Species Council, but it has not yet done so.

The problem of invasive species in Alaska will not go away, but the state has the chance right now to keep it from becoming a much bigger problem.

ACKNOWLEDGEMENTS

Special thanks to three reviewers and all those who contributed data and expertise to this project. We are indebted to Linda Leask and Steve Colt, Institute of Social and Economic Research; Denny Lassuy, US Fish and Wildlife Service; Michael Shephard, National Park Service, and Linda Shaw, NOAA, for early comments on our work. We thank the Alaska Natural Heritage Program for mapping support, and especially Lindsey Flagstad for her database expertise. Funding was provided by the Prince William Sound Regional Citizens Advisory Council, the US Fish and Wildlife Service, Ocean Alaska Science and Learning Center, the Alaska Legislative Council, and the Bureau of Land Management.

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