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# The Problem of Wildlife Poaching on U.S. Federal Lands

A PROBLEM SOLVING GUIDE



Wilderness Problems, Guide No. 1



Center for  
Problem-Oriented  
**Policing**

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## Executive Summary

Wildlife poaching, specifically on U.S. federal lands, is a serious issue comprised of unique opportunity structures. Wildlife poaching is defined as *the intentional or unintentional act of non-compliance with wildlife laws and regulations*. This guide seeks to provide information on how to best respond to the problem. Techniques for evaluating chosen responses are also offered and are structured in a manner that best suits adaptable policing. The primary goal of this guide is to inform the reader of wildlife poaching on U.S. federal lands and how to best address it by adapting a systematic approach to the problem.

This guide addresses wildlife poaching on federal lands managed by the United States. As such, this guide may be useful for such agencies responsible for federal land management (often referred to as public lands) as the U.S. Forest Service, National Park Service, Fish and Wildlife Service, and the Bureau of Land Management

In total, these four agencies manage approximately 606.5 million acres of land or 27% of the total land in the U.S.<sup>1</sup> According to the *2016 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation*, approximately 39.6 million people participated in hunting or fishing.<sup>2</sup> Much of the hunting and fishing took place on private lands, but a sizeable proportion also took place on land managed by the U.S. government. Around 3.9 million hunters used public land. When disaggregated, hunters pursuing big game utilized public land more so than those pursuing small game. These descriptive statistics only showcase the relative participation in hunting. Estimates of wildlife poaching are difficult to obtain, yet the widespread negative effect of unaltered poaching can be devastating biologically, ecologically, and economically for local communities. Other missing estimates are the immeasurable opportunities that exist on federal lands to hunt *illegally*. Particularly, federal lands act as a haven for many wildlife species, and often big game ones that are federally protected or sought after.

When presented with the right opportunity, a hunter (previously or latently motivated) may choose to poach when combined with low guardianship. Guardianship can be direct (conservation law enforcement or land managers) or indirect (nearby recreationists). U.S. federal lands, due to their size and terrain, present constant opportunities for low guardianship and hunting. It is also important to consider that no single definition, aside from strict legalistic views such as simply not following the law, exists to describe a “poacher”. Any hunter can *become* a poacher given the right opportunities. There also exists the possibility that ignorance of the law due to the difficulty and ever-changing status of wildlife regulations may lead to poaching incidents. For example, the seasonality and geographically specific nature of wildlife regulations can lead to confusion and thus, accidental poaching. To help classify poachers though, this guide discusses three categories: (a) individuals who live on or near federal lands (i.e., residents); (b) non-residents using assistance such as hunting guides; (c) and non-residents without assistance. Common among all the groups are motivations, such as commercial gain, consumption, thrill killing, and rebellion among others. The weapons and methods used for wildlife poaching are also commonly restricted to similar weapons and methods used for legal purposes, such as guns, dogs, traps, and bow and arrows. Poison, snagging, and spotlighting are methods that are likely universally illegal except for the rarest exceptions.



To combat wildlife poaching and to assist local conservation law enforcement efforts, a multitude of stakeholders may need to be involved, including hunters, land managers, gun shop owners, and hunting guides. With input from relevant stakeholders, the right questions must be asked when considering how to best understand a given poaching problem. These questions are based on the poaching incident, the location of the incident, offender characteristics, the targeted species, and any current responses. After information is gathered concerning the poaching problem, effective responses can be constructed with general and specific considerations. Generally, an adaptable response is required, and an appropriate goal should be set. Specific responses to reduce poaching can follow the framework of situational crime prevention. Efforts to extend guardianship and increase surveillance can be primary responses to be employed. Specific responses range from locking appropriate gates and blocking access points to working with local court systems and businesses to deny benefits to poachers.

Any POP approach to wildlife poaching on U.S. federal lands needs to be open-minded and adaptable. Many of the proposed responses in this guide are based on similar responses to other types of crime. This guide has fully incorporated the present knowledge on effective POP strategies and adapted them to the problem of wildlife poaching on U.S. federal lands, despite the fact that empirical evidence directly supporting the proposed responses is generally either lacking or only marginally supportive. When the problem is properly understood, the best responses can be utilized. Evaluations of responses and their effectiveness should also be a continuing consideration as the problem can change and require a different response. Wildlife poaching will continue and the factors driving it are likely to change. Therefore, responses must be based on the best information available with the consideration for change and improvement.

## The Problem of Poaching on Federal Lands in the U.S.

This guide addresses the problem of wildlife poaching on federal lands managed by the United States. Wildlife poaching is defined as *the intentional or unintentional act of non-compliance with wildlife laws and regulations*.

The guide begins by describing wildlife poaching followed by a discussion of best practices for analyzing and responding to the problem. This guide does not cover poaching outside of the United States or poaching on private or state-owned lands, although the discussion and some solutions presented here may be relevant to those issues as well. The goal of this guide is to provide law enforcement and wildlife/land managers a comprehensive overview to inform them about the topic of wildlife poaching, as well as offer relevant responses. This guide is another tool in the land manager's "toolbox" for problem solving and decision-making actions.

### What this Guide Does Not Cover

A related issue to wildlife poaching is the illegal wildlife trade. This is an issue that threatens thousands of species across the globe<sup>3</sup> and is estimated to be a multi-billion-dollar industry.<sup>4</sup> The proliferation of poaching has created black markets in countries across the world and local markets within the U.S.<sup>5</sup> It is common for poached wildlife products to be exported and imported into the U.S.<sup>6</sup> A domestic market with international connections was recently discovered in South Carolina involving the smuggling of thousands of protected turtles.<sup>7</sup> While this guide does not cover the illegal wildlife trade it is an important issue to contemplate when dealing with your local problem.

More broadly, wildlife poaching on U.S. federal lands is part of a larger set of problems occurring in wilderness or other conservation areas. It is also related to domestic and international markets for wildlife products, some of which are illegal. However, this guide only addresses the problem of wildlife poaching on U.S. federal lands. Related problems with specific opportunity structures not directly addressed in this guide include:

- Wildlife poaching on state or private lands
- The illegal possession of firearms
- Theft
- Violent crimes
- Domestic and international markets for wildlife products
- Defaunation
- Poaching of plant species. E.g., Ginseng, rare flowers, and timber
- Conflicts stemming from state's rights. I.e., State vs federal government control of land and wildlife
- Theft of historical artifacts and relics. I.e., Native American artifacts in the Southwest
- Drug cultivation/manufacturing

### Poaching Problems

The problem of wildlife poaching goes beyond the loss of an animal(s). There are related consequences caused by poaching that may be more difficult to identify and measure. These related problems may also be the responsibility of other governmental agencies. Nonetheless, the related biological and ecological consequences from poaching are important for any reader of

this guide to acknowledge. The following section covers the biological and ecological consequences related to poaching.

### Biological

Countless species have been driven to extinction or near extinction due to a combination of habitat loss and poaching.<sup>8</sup> The poaching and depletion of prey species can also have a significant impact on predator species.<sup>9</sup> Left unchecked, poaching can cause the diversity of wildlife species to dwindle significantly. For example, there is currently an increasing overseas demand for different parts of the American black bear. While estimates are difficult to obtain, the increase in poaching can greatly reduce black bear populations at the local level.<sup>10</sup> Other examples include the poaching of threatened sturgeon species in the Great Lakes and Pacific Northwest region for their caviar.<sup>11</sup>

### Ecological

The interconnectedness of wildlife and their environments play vital roles in the total health of an ecosystem. The re-introduction of the gray wolf into Yellowstone National Park, for example, has had profound positive effects on other animal species, plants, and the water ecology of the surrounding area.<sup>12</sup> After the introduction of the wolf, the elk population declined to more stable and healthy numbers. This, in turn, increased the survivability of young aspen tree shoots which then provided more shade along streams and rivers, thus, decreasing water temperatures and providing better habitat for native cutthroat trout. The elimination of a single species due to poaching can have significant impacts to the ecosystem.

### Poaching Techniques

Wildlife poaching on U.S federal lands can broadly be categorized into four stages: preparation, pre-activity, activity, and post-activity. These stages describe the process for which the problem occurs and the subsequent consequences.<sup>13</sup>

The preparation and pre-activity stages are closely related and refer to the situational and socio/physical environment for the crime to happen and the behavior of the poacher before the crime. Specific to the problem of wildlife poaching, the design and management of federal lands may influence the early decisions and actions of the poacher. To start, a potential poacher may ask themselves where will they go? How will I get there? What supplies do I need?

Further, the design of many U.S. federal lands are largely devoid of any major human development. Instead, large expanses of land are left in a natural state and are open for human access. These areas are also prime wildlife habitat. Additionally, in many of the federal lands, such as the national forests, a large complex of graveled 4x4 roads exist (in some cases paved); many of which are primarily used for logging or fire prevention. These roads can often be utilized by hunters, too, enabling easy access to areas deep within the protected land.

The poacher may utilize the relative unrestricted access to the protected areas and begin by scouting the environment just as legal hunters do. In the pre-activity stage poachers may track their victim (the animal), observe their surroundings such as the environmental conditions and presence of potential guardians (formal and informal), and make decisions based on these observations. Once the decision to poach is made based on their perceived opportunity, the



purchasing of weapons and ammunition and the recruitment of other individuals may occur. The order of preparation and pre-activity can vary greatly and is formed by the poacher building an awareness space from their observations. Based on these observations, whatever process works best given the situation is the one the poacher will likely choose.

There is also the possibility of poaching occurring during the process of a legal hunt. Hunters with initial intentions of hunting legally may come across an opportunity too good to pass. In this instance the federal land can be described as crime attractor where ill-intent was not the intended outcome until an opportunity presented itself.

During the activity stage, with attempts to remain undetected by others, including law enforcement and land managers, the act of poaching occurs. The poacher decides to illegally kill an animal or animals by using various methods. The methods used to kill the animal may involve firearms, traps, or poisoning. The weapon chosen may determine the legality of the act. Hunting laws are often seasonally defined and dictate the types of legal weapons that can be used. For example, deer season is often comprised of periods where certain methods of hunting are legal. A common deer season may be divided into periods such as archery, black-powder rifle, and full rifle.

The post-activity stage refers to the consequences of wildlife poaching on federal lands. After poaching the animal(s), the poacher makes the decision to try and dispose of the carcass, take certain parts of the animal, take the entire animal for meat or as a trophy, or just leaves the animal as waste. Depending on the location of the kill, many clues and evidence of the kill can be clear to outsiders such as a blood trail, spent cartridges, the initial noise (animals cries or gunshots), feathers and fur, etc. Some of these clues are not easily covered up and can often lead to the public discovering the incident. Depending on the severity of the crime and the type of animal involved, a public outcry can occur. For example, when evidence of wolf poaching on public lands is found in and around Yellowstone National Park, the public outcry can be wide-ranging. Additionally, when high levels of poaching occur in a single year or season, conservation efforts can be greatly impacted.

To supplement the above descriptions, an example of a crime script for pre-planned poaching is provided in Table 1. The crime script is comprised of four stages with the intention to view the crime as a process where at certain steps of the process, particular interventions can occur. The example provided in Table 1 is meant to serve as a template for law enforcement and wildlife managers to utilize when conceptualizing their own poaching problems. The readers' localized poaching problem may look very different than the example provided.

Table 1. *Example of a hypothetical deer poaching crime script*

Stages	Actions
Preparations	Scope out environment to find the best habitat for deer. Locate areas with easy access and line of sights. May also be a first step in baiting an area for future use.
Pre-activity	Enter into the protected area, set up hunting site by preparing a concealed area and readying weapon of choice. Locate deer by waiting or luring deer to the selected site. Luring can include manufactured deer scents, calls, or placement of food (baiting).
Activity	Poach one or multiple deer. Prepare the deer for exit by taking meat and or antlers. May also involve leaving the whole deer and trying to hide any evidence of poaching.
Post-activity	Leave the protected area on foot or by vehicle. Take the meat to a processing facility or enter deer product into black market for illegal trade.

### The Extent of the Problem

The poaching of big-game species in Africa and Asia, such as elephants, lions, tigers, leopards, and rhinoceros, are often the focus of international media attention, activism, and research<sup>14</sup>. In the United States, however, attention to poaching is typically limited to animals listed and protected by the Endangered Species Act. However, poaching, and related trafficking occur frequently in the U.S. and involve many wildlife species<sup>15</sup>. The methods of poaching can involve any number of methods such as the use of bow and arrow, rifles, shotguns, traps, poison, or spears<sup>16</sup>. Additionally, animals may be legally taken or killed in some areas during certain seasons, but not in others<sup>17</sup>. Factors such as the geographic location, time of year, weapon type, and protection of livestock must be considered when determining the legality of a kill. These factors are discussed in further detail throughout the guide.



Left: A local newspaper highlighting a case of poaching. Credit: Author.

### The Nature of the Problem

Understanding what wildlife poaching is and how it is defined is important for several reasons. First, a unified definition provides a better understanding of the problem when addressed by policymakers, conservation law enforcement officers, and researchers.<sup>18</sup> A single definition also helps align outcome measures across science and practice, especially when speaking to interdisciplinary stakeholders such as conservation and social science. Hunters are also stakeholders, they often act in a parallel environment where some types of hunting are legal, and others are considered poaching. To help determine how wildlife poaching should be defined, an analysis of commonly cited literature pertaining to wildlife poaching was conducted. The results of this analysis are shown in Table 2.

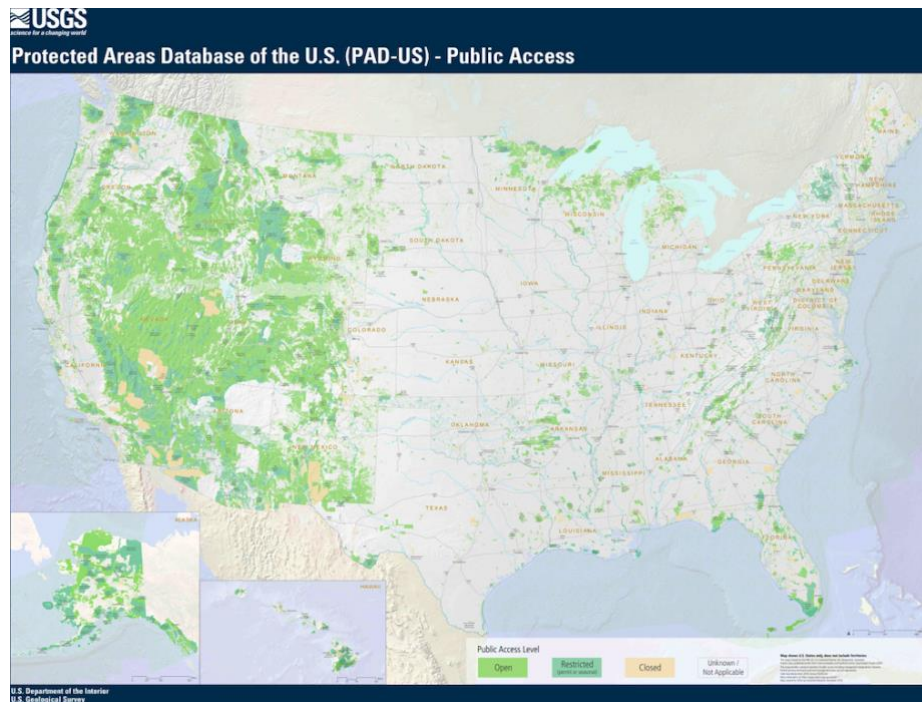
Table 2. *Definitions of Wildlife Poaching*

Definition	Source(s)
Illegal taking of wildlife	Crow et al., 2013; Eliason, 1999, 2012a; Filteau, 2012; Musgrave et al., 1993; Serenari & Peterson, 2016
Fishing in no-take zones	Bergseth & Roscher, 2018
Illegal taking (harvest) or killing of wildlife	Cooke et al., 2017; Eliason, 2012b; Gigliotti & Taylor, 1990; Peterson et al., 2017
Non-compliance and or deviation from regulations	Glass & Maughan, 1984; Kurland et al., 2017; Mayer et al., 2014; Solomon et al., 2015; Spencer et al., 2020
Wildlife crime	Wellsmith, 2011

Looking at the variety of definitions outlined in Table 2, wildlife poaching is often defined as the illegal taking of wildlife or a similar variant. However, it is also important to note that poaching can be intentional or unintentional.<sup>19</sup> For example, if a hunter misunderstands a hunting regulation and accidentally acts in non-compliance, the result is the same and the incident is considered poaching. To reiterate, in this guide, wildlife poaching is defined as *the intentional or unintentional act of non-compliance with wildlife laws and regulations*.

Specific to this guide, wildlife poaching is not limited to any single species and can include a wide range of potential targets. However, the problem typically involves a few select animals such as American big-game species. Animals considered “big-game” in the U.S. include elk, deer, bighorn sheep, cougars, brown and black bears, grey wolves, pronghorn, caribou, mountain goats, alligators, bison, and moose. Animals such as squirrel, waterfowl, and rabbits are also common targets.

U.S. federal lands are unique in that they are often very large in acreage and contain a high concentration and abundance of species biodiversity compared to the surrounding lands, with many species being threatened or endangered.<sup>20</sup> Wildlife commonly seek refuge on federal lands as they are often more protected from human interference and can freely roam.<sup>21</sup> Federal lands act as sanctuaries or “zoos” by attracting wildlife and limiting human disturbances of them. With the ever-increasing development of the natural world, federal lands are often the last places for many wildlife species to safely live without human predation or interference. However, the dedication of certain lands for conservation purposes can attract wildlife poaching due to the knowledge of the species availability within the protected lands.



Map of the United States and the federal public lands<sup>1</sup>

Hunters and owners of land surrounding federal lands are well aware that many animals live within the boundaries of these protected areas. This presents the opportunity to seek out wildlife for illegal purposes through poaching with the federal land existing as a conduit for criminal behavior. In the US, access to federal public lands is unique in that every American citizen has a right to access the land. Therefore, restricting access is extremely difficult and often contrary to the U.S. idea of conservation. However, limiting access to or altogether banning certain activities, such as hunting, is more common.

Internationally and nationally, there are laws protecting specific wildlife species. One example unique to the U.S. are the Lacey Act and the Endangered Species Act,<sup>22</sup> each of which outlaws the killing, possession, transportation, and trading of federally protected wildlife species in the United States. However, state wildlife and conservation agencies are responsible for making and enforcing policies for most wildlife species in the United States.

Regulations and laws can protect some species with total bans while allowing for the responsible consumption of others. In the United States, wildlife laws and regulations are often complex and defined by their seasonality, the species targeted, and other aspects such as the weaponry or caliber used to kill an animal. A problem, however, is that many National Park Service lands that do not allow hunting are surrounded by private or state lands that do allow hunting. Controversy can arise over baiting practices and boundary disputes. Often these occurrences of baiting are meant to lure animals onto un-protected lands from the adjacent

<sup>1</sup> Credit: U.S. Department of Interior. Source: [https://www.usgs.gov/core-science-systems/science-analytics-and-synthesis/gap/science/protected-areas-resources?qt-science\\_center\\_objects=0#qt-science\\_center\\_objects](https://www.usgs.gov/core-science-systems/science-analytics-and-synthesis/gap/science/protected-areas-resources?qt-science_center_objects=0#qt-science_center_objects)



protected land. These kinds of problems highlight the importance of proper dissemination and education of wildlife laws.<sup>23</sup>

Because most wildlife management occurs at the state level, and cases of poaching are hard to detect, accurate, national estimates of the problem do not exist. It is estimated though that wildlife poaching is on the rise in America and can be quite high on some localized levels.<sup>24</sup> The problem is so serious in some locales that certain species of wildlife are threatened with extirpation.<sup>25</sup> In conjunction with habitat loss, poaching is one of the highest threats to wildlife across the world and in the United States.<sup>26</sup>

Oftentimes wildlife protection, legislatively and through enforcement, is not enough to stop or greatly reduce poaching.<sup>27</sup> Due to the convergence of motivated offenders, suitable targets, and the absence of capable guardians, the opportunity for poaching is quite high in many areas.<sup>28</sup> The presence of these three factors is especially high on U.S. federal lands where vast expanses of land present many opportunities for poaching. The economics of the domestic and international wildlife trade are increasingly making poaching a growing domestic problem due to the high demand for animal parts in Asian markets, such as the American black bear.<sup>29,30</sup> U.S. federal lands are so vast that oftentimes effective wildlife law enforcement is extremely difficult or not a top priority for areas where other types of outdoor recreation are more popular. In addition, state wildlife agencies are also responsible for overseeing non-federal lands and their jurisdictional power may be limited to state-owned land.

### Who Poaches

A few typologies have been developed as an attempt to describe poachers and their behaviors.<sup>31</sup> Ten motivations cover the broad range of motivations poachers may have. These motivations are (1) commercial gain, (2) household consumption, (3) recreational satisfactions, (4) trophy poaching, (5) thrill killing, (6) protection of self and property, (7) rebellion, (8) traditional right, (9) disagreement with specific regulations, and (10) gamesmanship.<sup>32</sup> Poachers may exhibit any combination of these motivations.

The typical U.S. offender, as described by game and fisheries law enforcement, no longer poaches due to food necessity.<sup>33</sup> Instead, offenders are more presently driven by the economics of poaching, thrill or excitement, and relative low risk associated with the crime.<sup>34</sup> Many individuals, for various reasons, also poach due to purposeful disregard of regulations. These types of offenders typically do so as an act of defiance towards state or federal governance.<sup>35</sup> Others, simply poach due to ignorance of the law as well as the enjoyment tradition among family and friends.<sup>36</sup>

It is important to note that many offenders may have legally hunted in the past and due to various circumstances, including little prevention, decide to poach when presented the opportunity. The chances of getting caught are relatively low and the punishments do not act as a significant deterrence.<sup>37</sup> Poaching for big game species, especially those often available on federal lands, can be driven by the status or prowess regarding an individual's hunting skills.<sup>38</sup> In some cases, poachers just wanted to catch the biggest fish or "bag" the largest deer all while socializing with family and friends.<sup>39</sup> Overall, the offenders may be very similar to legal hunters and are difficult to differentiate.

While much of the relevant research has focused on labeling poachers based on their motivations, a different method is proposed based on geographic categorization. This system of categorization reduces the number of poacher types into three broad categories.

**Individuals who live on or near federal lands (i.e., residents).** It is known that offenders typically commit crimes near a central node or area the offender typically frequents.<sup>40</sup> These offenders are typically very knowledgeable about the area where they will commit their crimes. Offenders that live near federal lands sometime see the federal lands as an extension of their own backyards.

**Non-residents using assistance.** Often, hunting guides or local experienced hunters are recruited to help pursue wildlife legally and illegally. Poaching has become more complex and sophisticated over time and can be facilitated by large black-markets for illegally obtained wildlife.<sup>41</sup> These markets can include guide services which typically act in compliance with wildlife regulations, but when tempted with big paydays may help facilitate poaching activities.<sup>42</sup>

**Non-residents without assistance.** Some offenders will travel from across the country, state, and county lines to hunt certain species in areas they are not previously familiar with. Even if extensive traveling is required of the offender, a thorough research of the target area may be conducted combined with on-the-ground surveillance before the crime is committed. While not widespread, it is common enough that each year many National Parks investigate cases of poaching by visitors who are not considered local.<sup>43</sup>

### What Species are Poached

The targets for poaching on federal lands can include any wildlife species. However, the species most targeted can often depend upon black market prices for their fur, meat, or animal parts. They can also be poached for personal use.<sup>44</sup> For example, the American black bear is often poached for their gall bladders which are a high value wildlife part in Asian markets.<sup>45</sup> Other animals such as the brown bear and grey wolf are prized for their fur. The bighorn sheep and rocky mountain elk that lives in and around Yellowstone National Park are revered among trophy poachers looking to score a once-in-a-lifetime kill for pride or boastfulness.<sup>46</sup> Table 3 provides some example of wildlife targets, their products, and the use of their products.

Table 3. *Targets, Products, and Their Use*

Target	Product	Use
Dall Sheep	Trophy	Personal
Bald Eagle	Feathers	Jewelry
Black Bear	Gall Bladder	Traditional Chinese Medicine (TCM)
Elk	Trophy and Velvet-covered Antlers	Personal, TCM, and supplements
Sturgeon	Caviar	High-end culinary
Deer	Antlers and Meat	Personal and food
Walrus	Tusks (ivory)	Ornamentals



Confiscated Walrus Tusks<sup>2</sup>

Poached wildlife is not killed or captured strictly for consumption, trade, or prestige. Human-wildlife disputes are also a precipitator of poaching and commonplace along shared borders with public lands.<sup>47</sup> The American bison is a symbolic example where wildlife has been brought back from the brink of extinction and is now safeguarded on numerous federal lands. However, bison are often despised by nearby property owners for many reasons, such as overgrazing of lands, possible spread of disease to livestock, and causing property damage. Conflicts have arisen between the landowners and wildlife, leading to some individuals illegally luring animals off federal lands and onto private property so that they can kill them. Poisoning and trapping are other methods of poaching used by landowners who determine certain wildlife species as nuisances (ex. wolves). In some cases, private landowners are within the law to dispose of nuisance wildlife on their property; however, when the animals are lured or federally protected any killing is most likely deemed illegal and defined as poaching.



Elk are prized among hunters and poachers<sup>3</sup>

<sup>2</sup> Credit: USFWS. Source: <https://digitalmedia.fws.gov/digital/collection/natdiglib/id/14218/rec/11>

<sup>3</sup> Credit: USFWS. Source: <https://digitalmedia.fws.gov/digital/collection/natdiglib/id/18442/rec/3>

Because wildlife on public lands are not privately owned by any individual or entity, there is a diffusion of responsibility for their protection by the U.S. government. The lack of consistent and direct guardianship, though, makes it difficult to track the movements of wildlife or estimate their population. These issues make it much harder for wildlife biologists and conservation law enforcement to accurately determine what animals are being directly targeted and by how much. However, just like traditional law enforcement work, the levels of poaching are often discerned from the known cases and there is a significant void with unrecorded crimes, which is referred to as the “dark figure of crime”.<sup>48</sup> It is likely that these rates are extremely underestimated and only a small percentage of poaching cases get discovered.<sup>49</sup>

### Geographic Trends in Poaching

Wildlife poaching on federal lands is a much more common problem in the western U.S. than in the eastern U.S. due to the availability of public lands.<sup>50</sup> The abundance and the diversity of species combined with vast size of public federal land and a low density of people make the western states, specifically, the Rocky Mountain states (i.e., Montana, Utah, Idaho, Colorado, Wyoming, New Mexico, Arizona, and Nevada), prime locations for poaching. The high frequency of human interaction, urbanization and population density on the East Coast has led to lower species diversity. There is also low federal land ownership compared to the western states. However, poaching occurs on eastern federal lands as well.

In general, poaching occurs on any federal land where a wildlife species sought by a poacher exists. National park lands often have very high species diversity, but they also have much higher concentrations of tourists, making it more difficult to go unnoticed. Lands managed by the United States Forest Service (USFS) are often much larger compared to National Park Service (NPS), and are less visited in concentrated areas, reducing the risk of getting caught. Species diversity on USFS lands can be roughly equal and possibly increased in some areas due to less human interference. Land managed by the Bureau of Land Management (BLM) and United States Fish and Wildlife Service (USFWS) can also be quite large and contain high species diversity with low visitation compared to NPS and USFS lands.

Despite the dissimilarities between the different types of federal land, any land type can be attractive for a potential poacher if the opportunity exists. Locations within the federal lands that are suitable for poaching are dependent on the ability of travel to and from considering gear requirements. It is likely that most poachers will be near roads or other trails where they can easily track, kill, and transport their game.<sup>51</sup> For poachers who are more economically driven, going further into the federal lands and “off the beaten path” may be worth the effort considering the potential economic gains of certain species.

### Temporal Trends in Poaching

The practice of hunting is unique in that the legality of a hunt depends on a few temporal factors, such as season, day, and time. Poaching can occur congruent to legal hunting or outside the scope of legally defined hunting periods. Additionally, the availability of species based on breeding, migration, and hibernation creates temporally situated opportunity structures. Targets may not be available at all times due to hibernation or migration and the selection of a target may be influenced by timing.

Poaching can occur during any time of the year, day or night. Seasons, migration patterns, and official hunting seasons can all affect the levels of poaching. However, when monetary gain is high or the opportunity to kill a trophy sized animal is present and risk of getting caught is relatively low, poaching is likely to happen.<sup>52</sup> The more opportunities that are present, regardless of the time, day, or season, can lead to increased wildlife poaching given motivated offenders and a lack of effective preventative measures.<sup>53</sup> Research has found that much poaching occurs during the legal hunting season under the guise of legitimacy and increased opportunities.<sup>54</sup>

While foul weather or nighttime may inhibit some poaching activity, there are almost endless gear choices to reduce the discomforts or troubles presented by these factors. Additionally, legal hunting seasons often occur in shoulder seasons such as Spring and Fall where the prevalence of bad weather is high, therefore most hunters are adequately suited for such scenarios. Nighttime limitations can be overcome by spotlight or the more recent technology, night vision.<sup>55</sup> The beginning of legal hunting seasons may even aid in poaching activities by disguising suspicious noises such as gunfire.

Defined hunting seasons also dictate which animals are legal to hunt. Certain species may only be legally hunted during specified period of times. For example, in many eastern states, deer are typically hunted in the fall, and turkey are hunted in the spring. Certain species are also allowed to be hunted at night while restrictions are placed on other species to allow hunting during daytime hours only. Nighttime hunting in many areas though is illegal for most species. There is an immense amount of variety on this topic and the differences are vast among all fifty states and within certain geographic levels within states.<sup>56</sup>

### What Tools are Used for Poaching

Crime facilitators are tools which play an important role in aiding offenders to commit crimes or disorder.<sup>57</sup> Weapons and other similar variants are known as physical facilitators. Physical facilitators help to increase wildlife poaching on federal lands by providing methods which further enable the offender to commit the crime. Weaponry is an absolute to poach; enabling the poacher to track, target, and kill or capture. There are also tools that can augment an offenders' ability to poach and overcome preventative measures. Many offenders may use trucks, boats, or off-road vehicles to access areas that may be difficult to access by conservation law enforcement or land managers.<sup>58</sup> Additionally, many hunters are experienced in the outdoors and use a plethora of gear to help them survive in the outdoors and successfully complete a hunt. Though illegal in many states for hunting purposes, a poacher may use night vision, heat sensors, suppressors, poison, traps or snares, or drones to locate and aid in poaching.<sup>59</sup> Some of these tools are often very expensive and can be difficult to obtain such as rare ammunition calibers that are designed for use on certain species. The more advanced tools also require large learning curves to understand and properly use; yet each can greatly improve a hunters' chances of killing an animal. Weapons such as firearms or bow and arrows are common tools of poachers. Each of which can be outfitted in many ways. Table 4 showcases some of the more common weapons and methods used to poach wildlife and includes a brief description of them.



Table 4. *Weapons and Methods of Wildlife Poaching*

Weapon/Method	Description
Baiting	Lure animals to specific location. A common example is marshmallows or apples.
Bow and Arrow	Used to hunt. Can be outfitted with sights. Examples include crossbow, compound bow, and recurve bow.
Dogs	Used to seek and corner animals. Sometimes aid in killing the animal.
Fishing Set-up	Many combinations of how fishing setups. Can include nets, multiple poles and or lures.
Gun (ex. rifle, shotgun, handgun)	Many combinations that can be tailored to specific animals and conditions.
Poison	May be used in combination with baiting with the intent to kill upon consumption.
Snagging	Often used for the poaching of sturgeon. Large hooks are attached to metal fishing line and thrown into the water and then “stripped” back to shore in the hopes of snagging a fish.
Spotlighting	Often used to “stun” or “freeze” an animal at night by shining a bright light at the animal. May involve a vehicle and can be used in combination with many types of weapons.
Trapping	Often used in combination with baiting whereas an animal is lured to an area and then trapped in any number of techniques. Common techniques include snares and cages.

## Factors Contributing to the Problem

Some of the rationale poachers have concerning their behavior has already been discussed above (motivations). To fully recognize and respond to problems on your federal land, though, a better foundation of why individuals decide to poach must be realized. It is important to recognize that many factors can influence criminal behavior and no single factor explains all poaching. Instead, a combination of reasons explains why individuals decide to poach.

Perhaps, one of the more important factors is a social component (facilitator). Social facilitators enhance the opportunities of offending by normalizing the actions of the offender. Hunting is often a social activity and the skills for hunting are often passed down from generation to generation of family members. The skills required for hunting can be a bonding experience for families and groups of friends. Knowledge and skills for poaching can also be passed down in these groups and are often neutralized by group members.<sup>60</sup> The activity of poaching can become competitive within the groups and facilitate further criminal activity as group members seek to kill larger and more prized animals for prestige.

## Understanding Your Local Problem

The summary of what is known about wildlife poaching on federal lands only provides an under-developed understanding of the problem. To fully comprehend your local problem, you must combine previous knowledge with specific information of your local conditions. Carefully analyzing your local problem will help you design an effective response strategy that fits your specific needs.

The following methods can be used to collect additional information about your problem locally. Primary and secondary data collection are necessary for understanding the origins of your problem. The techniques below are suggestions for how to gather information that can be analyzed and interpreted to suit your local needs.

- Administer an in-person survey to hunters in popular areas. This survey should focus on gathering relevant information pertaining to poaching in the area.
- Set-up trail cameras in camouflaged areas around known hunting areas that are popular. Review the captured images to corroborate hunter kills or investigate poaching cases.
- Observe the actions of hunters and federal land users for illegal behavior(s) outside of poaching.
- Collaborate with federal and state fish and wildlife agencies to obtain data on poaching.
- Talk to local landowners that live near federal lands concerning nuisance species. The focus should be on issues that may have arisen in the past and the outcomes of those situations.
- Check local wildlife memorabilia stores and restaurants for illegal wildlife products.
- Monitor online discussion forums or social media and local marketplaces for suspicious activity.

- Cooperate with researchers and nature organizations to facilitate the sharing and analysis of data. Ongoing studies may have data relevant to poaching issues.

### Stakeholders

To better understand your wildlife poaching problem many groups with differing levels of topic knowledge may need to be involved in the process. Local hunters, wildlife and land managers, as well as outdoor recreation shops (e.g., gun shops, taxidermy shops, hunting guides) may need to be communicated with. From a more broadened sense, animals' rights groups, and the everyday American citizen may raise concerns of your local problem. These groups may not be a part of the response to your problem, but their input and communication may affect other variables such as policy.

### Asking the Right Questions

The list of questions below gives examples of what you should consider when trying to better understand your wildlife poaching problem. The answers to these questions will help you choose the most appropriate responses and develop an effective strategy to reduce incidents of wildlife poaching on federal lands.

#### Incidents

- If not your own, which agency oversees the classification of poaching incidents and is the information shared?
- How are these incidents reported and recorded?
- How many incidents occur on land you are managing?
- Is the number of incidents increasing or decreasing?
- What is the primary weapon used for the wildlife poaching?
- Where did the incident take place?
- When did the incident take place?

#### Locations

- How hard is it to reach the area?
- How far is the nearest road or all-terrain vehicle trail?
- Can the location be reached within a day's walk?
- Are automobiles or ATV's necessary to reach this location and transport the poached wildlife?
- How many repeat offenses does this area have?
- Where do offenders park their vehicles before travelling on foot or via ATV?
- Will offenders need to sleep overnight?
- Are there signs of camping?
- When are incidents most common (e.g., day or night, day of week, time of year)?
- Are incidents clustered together (e.g., seasonally)? Which season has the most clustering?
- Have harsh weather conditions occurred recently and what type?
- When is legal hunting season for the victim species?
- When do animals migrate in this area?

### Offenders

- What proportion of visitors to your land are local compared to non-local?
- What proportion of offenders are part of a hunting guide service, licensed to hunt but not in the area where the incident occurred?
- What are the underlying motives for the offenders?
- Why did the offenders choose a particular location?
- Is the offender a repeat offender for any (similar) crime?

### Targeted Species

- Which animal species is being targeted? Were multiple species targeted?
- Can the targeted species' parts be sold on the black market?
- Is the animal species considered a trophy kill?
- Is the animal species considered a nuisance animal?
- Is the animal species protected by the Endangered Species Act?

### Current Responses

- What resources does your department have available to use in addressing the problem?
- Which department manages this area if not your own?
- Are there other management stakeholders involved?
- Does the area allow legal hunting?
- Does the area have special wildlife protections such as prohibited hunting in recreation designated sites? What are they?
- What percentage of surrounding land is public and private?
- Is the area considered more rural or urban?
- Who else frequents the area to provide natural surveillance (i.e. tourists, hunters, etc.)?

### Measuring Your Effectiveness

Tracking your progress from beginning to end allows you to determine what your efforts have accomplished, and whether any modifications are necessary. To effectively measure your progress, you should record measures of your problem before and after you implement responses. This will allow you to determine the degree of the problem and whether your response was effective. Your measurements should be taken in the target and surrounding areas to watch for geographic displacement (poaching moves to a new zone) and/or the diffusion of benefits (poaching declines in all zones). Other examples of displacement should be monitored such as temporal and poaching method displacements. The following are potentially useful measures of the effectiveness of responses to wildlife poaching on federal lands:

- Fewer cases of wildlife poaching on land you manage.
- Fewer cases of wildlife poaching on surrounding federal lands, if applicable.
- Fewer cases of wildlife poaching on surrounding private lands, if applicable.
- Fewer complaints of wildlife poaching by federal land users.
- Fewer counts of suspicious vehicular activity on roads during the night and/or non-hunting seasons.

Remember that poaching is a difficult crime to detect and has a large 'dark figure'. Decreases in recorded poaching can simply mean a decrease in enforcement effort to identify the crime or less reporting from the public about suspicious activity related to poaching. Conversely,

increased effort from law enforcement or greater awareness in the community may actually result in *more* poaching incidents recorded in official data sets. By triangulating multiple data sources, including interviews and other contextual information beyond counts of poaching incidents, you will be better able to determine how your intervention is affecting the problem.

## Responses to the Problem

The majority of protected federal lands for conservation purposes in the United States are managed by a few government agencies and are concentrated in the western states.<sup>61</sup> Knowing and understanding the differences among these agencies is crucial when responding to your problem. The four agencies that manage most of these lands include:

- U.S. Forest Service (USFS) located within U.S. Department of Agriculture (USDA)
- Bureau of Land Management (BLM) located within U.S. Department of Interior (DOI)
- U.S. Fish and Wildlife Service (USFWS) located within U.S. Department of Interior (DOI)
- National Park Service (NPS) located within U.S. Department of Interior (DOI)

Importantly, the oversight, management styles and hunting regulations of these agencies differs. The USFS within the USDA is premised on sustainably using natural resources while also providing responsible recreational opportunities. The other three agencies within the DOI manage the land and its resources for protection while allowing for some types of recreation. The NPS for example does not allow any hunting except in a few special circumstances. The USFS, on the other hand, typically allows hunting on many of its lands. Examples of the types of protected lands are National Forests, National Parks and National Monuments, Wildlife Refuges, and Wilderness areas.

The analysis you conduct of your local problem should increase your knowledge of the factors contributing to it. Once you have a comprehensive foundation of knowledge for your local problem you should think and plan for possible responses to address the problem.

The following responses provide ideas for addressing your specific wildlife poaching problem. Many of these strategies are drawn from previous research, theories, and the past actions of land managers and conservation law enforcement. However, due to the limited evaluative research presently available on this topic some responses are more assumptive than others. Nonetheless, situational crime prevention techniques are widely supported in criminological work as well as in wildlife poaching prevention strategies.<sup>62</sup> Not every response included here will be applicable for your location though. It is up to you to use your best judgement when selecting a response to utilize. Carefulness should be stressed when tailoring a response to your local problem and should have justification for administering the response.

The responses are laid out by section and may apply to more than one area. Each response mimics a technique(s) of situational crime prevention. For more information regarding situational crime prevention, follow the link in the footnote.<sup>4</sup> Each response is bolded with the

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<sup>4</sup> <http://www.popcenter.org/learning/60steps/index.cfm?stepNum=38>



situational crime prevention technique in parentheses. Innovative thinking is also required, and some problems will need very different solutions than those provided below.

### General Considerations for an Effective Response Strategy

The combination of a wide range of poachers' motivations and ample opportunities with the low likelihood of being caught make wildlife poaching on U.S. federal lands a continuing problem. Given the vastness of available land, lack of enforcement, and regulatory dissimilarities, a structured and problem-oriented approach is warranted to combat the wildlife poaching. An open-minded and adaptable response by conservation law enforcement and other stakeholders is required. More research, particularly evaluative studies, are necessary to gain a better understanding of the problem and best strategies to combat it. Lastly, an appropriate and realistic goal should be set before any response is employed. For example, eliminating all poaching is unobtainable (with the exception of null enforcement of the problem). A more appropriate goal would be to reduce poaching by some measure such as a proportion of the known cases.

### Specific Responses to Reduce the Problem of Poaching

#### Law Enforcement

1. **Increase patrols during mating and migration seasons for trophy species. (Extend guardianship and strengthen formal surveillance).** While this may seem obvious, small details can often be overlooked concerning certain species. For example, it may be deer season, yet another popular game species (out of season) may be migrating near the area as well. Because attention is often concentrated on animals that are in season, such as deer, other animal species can be overlooked. The migration patterns and mating patterns of all potential victims of poaching should be analyzed and categorized by time of year.
2. **Lock appropriate gates and block access points commonly used by poachers. (Control Access).** Federally protected land is likely accessible in many places. Make sure all appropriate access points with gates are properly locked and maintained. Placing large rocks or other obstacles around gates will limit the ability of poachers to drive around the gate and access the land with an ATV or other off-road vehicle. Decreasing motorized access will increase the effort and time needed to hunt, kill, and transport any poached wildlife.
3. **Establish relationships with local taxidermists, meat processors, and hunting guides. (Extend guardianship, disrupt markets).** Taxidermists, meat processors, and hunting guides can be utilized as a resource for alerting your law enforcement agency to potential cases of poaching. Illegally killed animals may be brought to a taxidermist or meat processor without the proper tags or legal certification of the kill. Information on the suspect should be communicated to law enforcement by the taxidermist and meat processor. Hunting guides are often approached to help hunters kill a trophy animal at any cost. Sometimes, the methods suggested are illegal. If a good relationship is established with local hunting guides, a line of communication can be operational between them and law enforcement. Whenever a potential client suggests illegal hunting strategies, the guide can alert the law enforcement.
4. **Establish and utilize road checkpoints. (Reduce anonymity, control access).<sup>63</sup>** Establish checkpoints along major roads leading to popular hunting areas. Confirm that hunters have the proper licenses and wildlife tags. Direct observation combined with

questioning can lead to a fair amount of data, which can be used to uncover possible cases of poaching.<sup>64</sup> Officers should start conversations with hunters at the checkpoints; trying to gather information and intelligence about legitimate hunting practices and poaching in the area. This time should also be used to educate hunters on regulations and concerns regarding poaching in the area.

5. **Reduce the level of non-law enforcement duties for conservation law enforcement.**<sup>65</sup> **(Strengthen formal surveillance).** Increasingly, the duties for conservation law enforcement have expanded outside of wildlife protection and include animal control, boating and park enforcement, and policing of nearby localities with limited law enforcement resources such as for rural towns or roadways. These additional duties limit the officers' ability to conduct thorough investigations and concentrate on wildlife poaching crimes.
6. **Identify areas prone to poaching based on past reports and incidents and set-up game cameras. (Formal surveillance).** The game cameras should be placed alongside popular game or recreation trails and on the edges of clearings or where wildlife is known to congregate. The placement of the cameras should be well-hidden, but not obstructed. Images from the cameras may help law enforcement to track or identify poachers. Additionally, images may be used in court to strengthen the prosecution's case against the offenders. There are examples of non-profit wildlife conservation groups installing game cameras and reporting illegal or suspicious activity to law enforcement.<sup>66</sup> Contact local groups for possible collaborations.
7. **Create a data collection system for all reports and cases of wildlife poaching to use for future analysis and reference.**<sup>67</sup> **(Strengthening formal surveillance).** This system should include accurate reports of the time, date, location, weather, animal species that was poached, and other variables useful for investigating the crime. Currently, many wildlife agencies may not have very accurate means of recording and analyzing crime data. Accurate reports can be very useful for analyzing trends and conducting temporal analysis. Additionally, recorded data may also reveal patterns previously unknown or overlooked.
8. **Increase funding for your conservation law enforcement department. (Strengthen formal surveillance).** Dwindling budgets have led to lower salaries, increases in turnover rates of employees, and decreased job satisfaction.<sup>68</sup> It takes a lot of money and time to train a new officer and familiarize them with the local area and the problems within the area.<sup>69</sup> A low retention rate makes it more difficult for law enforcement operations and investigations. Additionally, as equipment prices increase, so should budgets. Conservation law enforcement agencies utilize very specialized equipment that is sometimes atypical of a normal police department. This equipment, while expensive, is necessary to properly work in harsh environments and detect incidents of wildlife poaching. While an increased budget would allow for many of the responses to be properly implemented, the trouble is advocating and receiving the increased budget.
9. **Identify species that have high value body parts. (Disrupting markets).** These animals are often deemed trophy animals or species commonly traded on the black market.<sup>70</sup> Investigate any instances of illegal wildlife trading at your localized level and then gradually broaden your scale. Hunting guides, taxidermists, and restaurants should be investigated as possible actors or informants in the illegal wildlife trade.

**10. Work with local court systems and judges to stress the importance of convicting and punishing wildlife poachers. (Deny benefits).** Many conservation law enforcement agencies feel their work is undermined by the court systems and offenders often get away with their crimes.<sup>71</sup> Contact your local court system and explain the negative impacts that poaching has on the local economy and wildlife populations. It is important to stress how wide-ranging the impacts of wildlife poaching are and the necessity of punitive actions against offenders.

#### Civil Society

**11. Acknowledge that a hotline for citizens to report potential cases of wildlife poaching can be beneficial. (Assist compliance).** Research has found that this hotline needs to be carefully managed and widely advertised, and that tipsters must be educated in local wildlife laws for the tips to be beneficial.<sup>72</sup> Meetings to educate the public on local wildlife laws should be established at the local level. These meetings should advertise the hotline and how it works. Additionally, information should be provided to the public concerning the best practices for communicating possible incidents of poaching. A more specific example called “Turn in a Poacher” was implemented in Pennsylvania with the goal of identifying and deterring poachers.<sup>73</sup> The grassroots program was successful in alerting law enforcement to the growing trends of poaching occurring in the state; however, this was reactionary information and not preventative. Nonetheless, the more information law enforcement and conservation managers have at their disposal the better.

**12. Work with local town leaders to educate the public on wildlife poaching.<sup>74</sup> (Assist natural surveillance).** People in rural areas will often not report poaching compared to more urbanized areas.<sup>75</sup> The problem is, most poaching occurs in rural areas. It is important to educate the public on the negative effects of wildlife poaching and that no level of poaching is acceptable. Many rural communities adjacent to federal lands economically depend on tourism to the area. Wildlife poaching can significantly impact a local economy, and this argument may be more impactful to rural citizens dependent on the hunting and recreation-tourism industry.

**13. Establish a relationship with local hunters, hunting guides, and businesses to educate them on the economic losses from wildlife poaching. (Alert conscience).** These individuals rely on hunting and local wildlife for their enjoyment and economic gain. While rich clients may present them the opportunity to gain a lot monetarily by poaching, the argument should also be made about the long-term economic losses that will result from poaching activities. The economic argument can be more useful than a conservation or ethical one in many instances. You should make it clear that poaching has far greater negative consequences than positive ones.

## Appendix. Responses Through the Lens of Situational Crime Prevention

The following table summarizes the important information for each of the above responses. Included in the table is a description of the response, how it works, when the response works best, and some factors you should consider before implementing a particular response. It is critical that you tailor these responses to your local circumstances and justify their use based on reliable analysis. For most scenarios, a combination of these responses is needed to adequately address your problem. A single response is rarely effective in reducing or solving the problem of poaching.

Response No.	Page No.	Response	How It Works	Works Best If...	Considerations
<i>Increasing Effort</i>					
1.	22	Increase patrols.	Increases law enforcement presence during mating and migration seasons for trophy species.	...staff are available to monitor and police the species.	Can be costly or overburden officers.
2.	22	Lock gates and block access points.	Limit road access to popular hunting areas.	...gates are installed and monitored.	Limits public access to federal public lands.
<i>Increasing Risks</i>					
3.	22	Establish local business relationships	Create a line of communication for reports of poaching.	...businesses can positively gain from the relationship.	May deter clients from the businesses.
4.	22	Establish checkpoints	Provides the opportunity for direct observation.	... there are enough officers to create multiple checkpoints.	May require too many officers, thus, limiting their in-field policing.
5.	23	Reduce non-law enforcement duties.	Limit the duties performed by law enforcement that are related to animal control and policing of nearby localities.	...budgets can withstand sheer dedication to conservation law enforcement duties.	Budgets are continually shrinking, and other duties may become necessary.
6.	23	Set-up game cameras.	Utilizes game-cameras to survey known poaching areas.	...Cameras and well-hidden but not obstructed.	May only provide evidence after-the-fact.
7.	23	Create a data collection system.	Law enforcement gathers, inputs,	...law enforcement is properly	Can be costly and involve extensive training.

			stores, and analyzes poaching data.	trained on what data to record.	
8.	23	Increase funding.	Increase funding to better equip and retain conservation law enforcement officers.	... money is available from the local, state, or federal budgets.	Funding has consistently dwindled and other avenues for funding need to be considered.
12.	24	Educate the public.	Conveys information about wildlife poaching to the public.	...if the public understands the negative effects of poaching.	May be hard to change rural citizens minds.
<i>Reducing Rewards</i>					
9.	23	Identify species that have high value body parts.	Creates a list of potential target species.	...if new trends in oriental medicine are tracked.	May defocus attention from other animal species.
10.	23	Work with local court systems.	Establishes a working relationship with the court system, stressing the importance of convicting poachers.	...a working level of collaboration can be established, and a sympathetic judge can be found.	Violent or property crimes will likely take precedence.
<i>Removing Excuses</i>					
11.	24	Create a poaching hotline.	Educate the public about poaching and how to use the hotline for reporting.	...the public is educated on wildlife poaching and what to report.	May overburden law enforcement with false calls or un-helpful information.
13.	24	Educate on the economic losses due to poaching.	Educate relevant stakeholders about the long-term economic consequences	... all relevant stakeholders are educated using clearly defined economic losses.	Can be difficult to estimate without quality poaching data.



			due to poaching.		
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## Endnotes

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- <sup>1</sup> Congressional Research Service (2020).
  - <sup>2</sup> U.S. Fish & Wildlife Service (2018).
  - <sup>3</sup> Phellps et al. (2016).
  - <sup>4</sup> Rosen and Smith (2010).
  - <sup>5</sup> Sosnowski (2019).
  - <sup>6</sup> Petrossian et al. (2016).
  - <sup>7</sup> Department of Justice (2019).
  - <sup>8</sup> O'Donoghue and Rutz (2015).
  - <sup>9</sup> Chapron et al. (2008).
  - <sup>10</sup> Musgrave et al. (1993).
  - <sup>11</sup> Cohen (1997).
  - <sup>12</sup> Beschta and Ripple (2015).
  - <sup>13</sup> Tompson and Chainey (2011).
  - <sup>14</sup> Moreto and Pires (2018); Warchol (2017).
  - <sup>15</sup> Gonzalez (2016).
  - <sup>16</sup> Eliason (2004).
  - <sup>17</sup> Eliason (1999).
  - <sup>18</sup> Eliason (2003).
  - <sup>19</sup> Spencer et al. (2020).
  - <sup>20</sup> Stein et al. (2008).
  - <sup>21</sup> Musgrave (2009).
  - <sup>22</sup> Musgrave et al. (1993).
  - <sup>23</sup> Falcone (2004).
  - <sup>24</sup> Muth and Bowe (1998).
  - <sup>25</sup> Muth (1998).
  - <sup>26</sup> Moore et al. (2018).
  - <sup>27</sup> Eliason (2003).
  - <sup>28</sup> Eliason (2012b).
  - <sup>29</sup> Eliason (2012b).
  - <sup>30</sup> Elliott (2012).
  - <sup>31</sup> Eliason (2013); von Essen et al. (2014).
  - <sup>32</sup> Muth and Bowe (1998).
  - <sup>33</sup> Eliason (2004).
  - <sup>34</sup> Eliason (1999, 2012b); Forsyth and Marckese (1993a, 1993b).
  - <sup>35</sup> Crow et al. (2013); Eliason (2003); Grisby (2012).
  - <sup>36</sup> Eliason (2004); Forsyth et al. (1998).
  - <sup>37</sup> Filteau (2012); Mayer et al. (2014).
  - <sup>38</sup> Chipman and Helfrich (1988); Eliason (2012b).
  - <sup>39</sup> Curcione (1992); Dawson and Wilkins (1981).
  - <sup>40</sup> Brantingham and Brantingham (1995).
  - <sup>41</sup> Brymer (1991); Muth and Bowe (1998).
  - <sup>42</sup> Curcione (1992).
  - <sup>43</sup> National Park Service (2016).
  - <sup>44</sup> Challender and MacMillan (2014).
  - <sup>45</sup> Kilian (2004).
  - <sup>46</sup> Irby et al. (1989).
  - <sup>47</sup> Moreto (2019).
  - <sup>48</sup> Biderman and Reiss, Jr. (1967).

- <sup>49</sup> Musgrave et al. (1993).  
<sup>50</sup> Eliason (2012b).  
<sup>51</sup> Weekers, Zahnow, & Mazerolle (2019).  
<sup>52</sup> Bergseth et al. (2017).  
<sup>53</sup> Eliason and Dodder (1999).  
<sup>54</sup> Eliason and Dodder (1999); Muth and Bowe (1998).  
<sup>55</sup> Kaminski (1974).  
<sup>56</sup> Spencer et al. (2020).  
<sup>57</sup> Clarke (1995); Braga and Clarke (2014)  
<sup>58</sup> Eliason (2011b).  
<sup>59</sup> Eliason (2004).  
<sup>60</sup> Eliason (2003).  
<sup>61</sup> Heisel (1998).  
<sup>62</sup> Kurland et al., (2017); Pires and Moreto (2011).  
<sup>63</sup> Weekers et al. (2019).  
<sup>64</sup> Gavin et al. (2010).  
<sup>65</sup> Eliason (2011b).  
<sup>66</sup> Taylor (2017).  
<sup>67</sup> Gavin et al. (2010).  
<sup>68</sup> Eliason (2011b).  
<sup>69</sup> Eliason (2011a).  
<sup>70</sup> Challender and MacMillan (2014).  
<sup>71</sup> Eliason (2011b).  
<sup>72</sup> Green (2016).  
<sup>73</sup> McSkimming and Berg (2008).  
<sup>74</sup> Masse et al. (2017).  
<sup>75</sup> Eliason (2011b).

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