

LEAD FISHING TACKLE:

Impacts of California Wildlife
and the Environment

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Introduction

Lead is a dense, corrosion-resistant metal that has been in use since ancient times. Lead ore deposits are abundant in North America, making it an inexpensive and popular material in a wide variety of applications today. Lead is also a potent neurotoxin, dangerous to both vertebrate and invertebrate animals. Even a small amount of lead taken into the body can cause toxicosis, leading to sickness or death.¹

Because it is inexpensive and denser than many other metals, lead has traditionally been the popular choice for fishing sinkers and other tackle. But in the last few decades, concerns have been raised about the risk of lead fishing tackle to wildlife and to the environment, leading to regulation in several states and countries. In England in the early 1980s, lead poisoning through the ingestion of lead fishing sinkers was determined to be the major cause of death in a species of swan. A subsequent ban on lead fishing sinkers weighing less than 29 grams resulted in a significant reduction in swan deaths.² Canada also banned the possession of lead fishing sinkers or lead jigs weighing less than 50 grams by anglers fishing in national parks in 1997.³ The United States has banned the use of lead sinkers and jigs in certain federal wildlife refuges, as well as Yellowstone National Park. Some states, including New Hampshire, Maine and New York, have ratified regulations prohibiting the use of lead sinkers.

¹ California Department of Toxic Substances Control (Aug. 2004) Draft Lead Report. https://www.dtsc.ca.gov/HazardousWaste/upload/HWMP_REP_dLead-Rep.pdf

² Sears, J. and Hunt, A.E. (1991) Lead Poisoning in Mute Swans *Cygnus olor* in England. <https://wildfowl.wwt.org.uk/index.php/wildfowl/article/view/1426>

In California, research on the effect of lead ammunition on birds in the wild resulted in the passage of Assembly Bill 711 (Rendon), which prohibits the use of lead ammunition for hunting game mammals and birds in the state by July 1, 2019 (Ch. 742, Stat. of 2013). There has been far less research concerning the impact of lead fishing tackle on wildlife and in waterways. At the request of the Office of State Assemblymember Bill Quirk, this paper provides a review of the available literature concerning lead fishing tackle and the impact on fish and other wildlife, as well as the results of queries made to wildlife rehabilitation centers along the west coast of the United States and Canada. It also includes a discussion of the number of anglers in California, and the potential means to gauge the amount of lead fishing tackle used by these anglers and lost in waterways.

Types of Fishing Tackle

Fishing tackle serves a variety of functions. A *fishing sinker* is a weight used on a fishing line to sink fish hooks, anchor a line, or increase casting distance. Sinkers come in all different shapes and sizes, and are used in both freshwater and deep sea fishing. A *fishing jig* is a type of hook that includes a lead sinker molded into it. Jigs are sometimes covered by a soft material to attract fish. A *split shot* is a small, round sinker that is pinched or tied onto a fishing line. Sinkers may be made of non-toxic materials such as brass, tungsten, steel or bismuth, or metals such as zinc. However, lead

³ Scheuhammer, A.M., et al. (2003) Lead Fishing Sinkers and Jigs in Canada: Review of Their Use Patterns and Toxic Impacts on Wildlife. Occasional Paper No. 108. Canadian Wildlife Service. https://www.researchgate.net/publication/287181064_Lead_fishing_sinkers_and_jigs_in_Canada_Review_of_their_use_patterns_and_toxic_impacts_on_wildlife

is still the popular choice for its density and low cost.

Federal and State Regulation of Lead Fishing Tackle

The federal government maintains specific regulations for lead fishing tackle in wildlife refuges, and may ban the use of lead ammunition or tackle in particular areas. In 50 CFR Part 32, general provisions are given on fishing in federal wildlife refuge areas. Subdivision B provides regulations for hunting and fishing in specific wildlife refuge areas. In some wildlife refuges, the use of lead-based fishing lures in sport fishing is prohibited. Currently, there are no prohibitions against lead-based fishing lures in federal wildlife refuge areas in California.⁴

States may regulate the use of lead in hunting and fishing. California does not currently regulate the use of lead fishing tackle. However, in California, Fish and Game Code Section 3004.5 regulates the use of lead ammunition when hunting within the range of the California condor.

Other states:

- Maine prohibits the use of lead sinkers or jigs weighing 1 ounce or less (Maine Rev. Stat. Title 12, Conservation Section 12664). Retail outlets are prohibited from selling lead sinkers or jigs weighing 1 ounce or less (Maine Rev. Stat. Title 12, Conservation Section 12663-B).
- Massachusetts prohibits the use of lead fishing sinkers and jigs less than 1 ounce in all inland waters (Title 321, Section 4.00 et seq.).

- New Hampshire prohibits the use of lead sinkers up to 1 ounce and lead jigs up to 1 inch in length in all waters (Title 28, Fish & Game Section 211:13-b). Retail outlets are prohibited from selling lead sinkers and lead jigs (Title 31, Trade & Commerce Section 339:77).
- New York prohibits the sale of lead sinkers ½ ounce or less (New York Environmental Conservation Law, Section 11-0308).
- Vermont prohibits the use of lead fishing sinkers ½ ounce or less (Title 10, Conservation & Development Section 4606(g)). It is also unlawful to sell lead sinkers weighing ½ ounce or less. However, this does not include other lead fishing-related items (Title 10, Conservation & Development Section 4615).

Lead Sinkers in the Environment

Under California's Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65, California Health & Safety Code Section 25249.5 et seq.), "lead and lead compounds" are listed as chemicals known to cause cancer.⁵

The California Department of Toxic Substances Control states that the rate at which lead dissolves in water depends on several factors, including the alkalinity of the water and the dissolved salt content. Lead can dissolve in soil over time, but the rate is also dependent on factors such as the acidity of the soil, particle size and type of the soil, and the presence of minerals. Lead can leach in soil, particularly in acidic soils with little clay, higher levels of chloride, and greater organic matter content.

⁴ 50 CFR Part 32:
<https://www.law.cornell.edu/cfr/text/50/part-32>

⁵ Office of Environmental Health Hazard Assessment.
<https://oehha.ca.gov/media/downloads/proposition-65/p65list112318.pdf>

Lead can also leach in soils where a higher concentration of lead is already present. Overall, the greatest cause of lead movement is mechanical action, such as churning against rocks in fast moving water, or soil tilling.⁶

These conclusions are supported by a study that has analyzed the effect of lead sinkers in water. In 2001, researchers in Sweden conducted an analysis of lead emissions from fishing sinkers lost in rivers. Lead sinkers were purchased and then dropped in various locations within four waterways. A few months later, most of the sinkers were recovered and analyzed for loss of lead. Some sinkers remained exposed in moving water; others were buried in sediment; still others were lost and unrecoverable. The amount of lead lost by the sinkers very much depended on where they landed and if they were coated with a secondary material. The researchers found that dissolution of elemental lead was influenced by the alkaline level of the water and by mechanical disturbance (such as water flow rate or contact with rocks). A coating of secondary material was found to decrease the lead dissolution rate. Sinkers that had been placed in rapidly flowing water showed the most weight loss, indicating that lead had entered the flowing water after repeated impact against rocks. Sinkers in brackish water showed some signs of corrosion. Researchers presumed that dissolved lead probably ended up in brackish water sediments in the sea.⁷

⁶ California Department of Toxic Substances Control (Aug. 2004) Draft Lead Report. https://www.dtsc.ca.gov/HazardousWaste/upload/HWMP_REP_dLead-Rep.pdf

⁷ Jacks, G., et al. (Sep. 27, 2001) Lead Emissions from Lost Fishing Sinkers. Helsinki: Boreal Environmental Research, vol. 6.

⁸ Pokras, M.A. and Kneeland, M.R. (2008) Understanding Lead Uptake and Effects across Species Lines: A Conservation Medicine Based Approach. In R.T. Watson, et al. (Eds.) Ingestion of

Ingestion by Fish

Though some species of adult fish appear to be insensitive to lead toxicosis, fish eggs and larvae have been shown to be greatly affected at low levels of exposure, resulting in population-level decrease.⁸ No major research examines the effect of fishing weight-induced lead ingestion by fish.

It is physically possible for fish to ingest small lead fishing sinkers, lead shot and bullet fragments that they uncover in the sediment of stream beds and other waterways. More commonly, fish ingest or become entangled in lead tackle during the act of angling. Many such fish are subsequently caught and die immediately. Other fish may get away, or may be released after capture. Studies have shown that survival of fish that are caught and released depends on the extent of injury, blood loss, exposure to air, and exhaustion during the removal of the tackle. Fish exposed to tackle while being caught generally do not live long enough to experience the effects of lead toxicosis. It is possible for a fish carrying embedded or ingested lead to be caught and eaten by a larger fish or a mammal, resulting in secondary lead poisoning.⁹

Ingestion by Birds

Lead sinkers, jigs and split shot weighing less than 50 grams and smaller than two centimeters are generally small enough to be ingested by birds. Due to the toxicity of lead,

Lead from Spent Ammunition: Implications for Wildlife and Humans. The Peregrine Fund. https://www.researchgate.net/publication/242551687_Understanding_Lead_Uptake_and_Effects_across_Species_Lines_A_Conservation_Medicine_Based_Approach

⁹ Rattner, B.A., et al (2008) Sources and Implications of Lead Ammunition and Fishing Tackle on Natural Resources. Technical Review 08-01. The Wildlife Society. <http://wildlife.org/wp-content/uploads/2014/05/Lead08-1.pdf>

ingestion of even one fishing sinker is sufficient to expose a bird to lethal doses of lead,¹⁰ and to dangerous levels of lead toxicity, or death, in a larger animal.¹¹

Birds are particularly susceptible to lead poisoning from shot and fishing sinkers because when lodged in the gizzard, the grinding action combined with the presence of digestive acids causes the lead to enter the digestive tract and move into the bloodstream. For instance, loons are known to ingest lead sinkers when they sift through sediment in the water, looking for invertebrates or possibly pebbles that aid in digestion in the gizzard.¹² Lead poisoning from fishing tackle has been documented in many varieties of bird, such as common loons, the mute swan, the trumpeter swan, American black ducks, the California condor, white and brown pelicans, and Canadian geese.¹³

Franson, et al. (2003) analyzed 28 species of waterbirds brought to wildlife rehabilitation centers between 1995 and 1999. One purpose of the analysis was to gain an understanding of what types of lead products had caused toxicosis. A total of 2,240 birds from 25 states, including California, were examined. The presence of fishing tackle was found in 23 individual birds of four species. The fishing tackle ingested included split shot, jig heads,

and various types of sinkers, with a size and mass of ingested lead sinkers ranging from 7 millimeters split shot to 22x39-millimeter sinker. Other birds had fishing hooks embedded in their skin.¹⁴

Dau, et al. (2009) examined the prevalence of injury and death in waterfowl and marine mammals due to ingesting or becoming entangled in fishing tackle. The study did not distinguish between lead and non-lead fishing tackle. The researchers reviewed six years of medical records (2001-2006) from select California wildlife rehabilitation centers, focusing on cases of injury and mortality in California brown pelicans, gulls and pinnipeds (California sea lions, northern elephant seals, and Pacific harbor seals). In a total of 9,668 case records, 14 pelicans, 53 gulls and 4 pinnipeds were treated for ingestion of fishing tackle.¹⁵

Ingestion by Mammals

A small subset of the literature concerning lead toxicosis in marine and land mammals focuses on lead fishing sinkers and tackle.^{16 17} The research does highlight a specific example in California. In June 2004, researchers examined a harbor seal at a rehabilitation center in Sausalito, Marin County. The seal was underweight for its age, dehydrated, and having

¹⁰ Scheuhammer, A.M. (2009) Historical Perspective on the Hazards of Environmental Lead from Ammunition and Fishing Weights in Canada. <http://www.peregrinefund.org/subsites/conference-lead/PDF/0105%20Scheuhammer.pdf>

¹¹ Zabka, T.S., et al. (2006) Acute Lead Toxicosis in a Harbor Seal (*Phoca vitulina richardsi*) Consequent to Ingestion of a Lead Fishing Sinker. *Journal of Wildlife Diseases* 42(3), pp. 651-657.

¹² Michael, P. (2006) Fish and Wildlife Issues Related to the Use of Lead Fishing Gear. Washington Department of Fish and Wildlife. <https://wdfw.wa.gov/publications/00037/wdfw00037.pdf>

¹³ Scheuhammer, A.M., et al. (2003)

¹⁴ Franson, J.C., et al. (2003) Lead Fishing Weights and Other Fishing Tackle in Selected Birds. *Waterbirds*, vol. 26 no. 3, pp. 345-352.

¹⁵ Dau, B.K., et al. (2009) Fishing Gear-Related Injury in California Marine Wildlife. *Journal of Wildlife Diseases*, vol. 45 no. 2, pp. 355-362.

¹⁶ Pokras, M.A. and Kneeland, M.R. (2008)

¹⁷ Eisler, R. (1988) Lead Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review. U.S. Fish and Wildlife Service.

<https://semspub.epa.gov/work/03/137426.pdf>

seizures. After the seal died, a necropsy revealed a lead fishing sinker in the animal's stomach. It was determined the animal died of acute, high-dose lead toxicosis consequent to the ingestion of the sinker. The researchers found it likely that the seal, while foraging for food, ingested a fish attached to fishing tackle used by either recreational or commercial anglers.¹⁸

Ingestion by Amphibians

Reptiles and amphibians are also affected by lead; adults of some reptile species are largely resistant, but aquatic eggs and larvae do appear sensitive, especially among those species that deposit eggs in waterway sediments.^{19 20} The literature includes few instances of lead fishing sinkers found in the digestive system of amphibians. Rattner, et al. (2008) describes three separate reports involving turtles found to have ingested lead fishing sinkers. In each of the cases, it was not clear whether the sinkers had resulted in the death of the turtles.

Wildlife Rehabilitation Centers

If a wild animal is discovered suffering from the effects of lead toxicity, the most common place to take it for assistance is to a wildlife rehabilitation center. These centers are located throughout the United States, providing care and treatment to injured, orphaned, or sick animals with the objective of releasing them back into the wild. Centers range in size from home-based operations to large-scale veterinary offices. Wildlife rehabilitation centers specialize in a range of animal types.

Detecting lead poisoning in living animals is usually done by analyzing blood samples at a veterinary office or rehabilitation center. If an animal is deceased, samples of the liver or kidney may be tested on-site, or sent to a laboratory to measure lead levels.²¹

As of August 1, 2018, the California Department of Fish and Wildlife lists 91 wildlife rehabilitation centers on its website.²² The Research Bureau contacted all 91 centers, as well as centers in Oregon, Washington and British Columbia.²³ Each center was asked 1) whether it tests for lead toxicity in the animal patients that are treated, and 2) whether it keeps track of lead toxicity cases.

Forty-nine centers responded to the Research Bureau's request for information. The majority of the respondents stated that they do not track lead poisoning cases in patient birds, amphibians and mammals. Further, few centers reported seeing cases of lead toxicity they could specifically attribute to the presence of fishing tackle. Of those that could identify a cause of lead toxicity in birds, most found the birds had ingested lead shot, not fishing tackle. A full response list is in the Appendix.

Only four rehabilitation centers reported that they routinely track lead poisoning cases in animal patients. The cases tracked were all bird patients. The UC Davis Veterinary Medicine-California Raptor Center stated that there has not been a case of lead poisoning from fishing lures and weights. PAWS Wildlife Center in Washington stated that it is rare to find cases of lead toxicity caused by fishing gear. Neither the

¹⁸ Zabka, T.S., et al. (2006)

¹⁹ Pokras, M.A. and Kneeland, M.R. (2008)

²⁰ Eisler, R. (1988)

²¹ Pokras, M.A. and Kneeland, M.R. (2008)

²² A current list of California wildlife rehabilitation facilities is maintained at

<https://www.wildlife.ca.gov/Conservation/Laboratories/Wildlife-Investigations/Rehab/Facilities>.

²³ These states and provinces were selected because they are along the Pacific Flyway and on the Pacific coast, in order to capture potential information about both migratory birds and marine mammals.

Discovery Bay Wildlife Rescue (Port Townsend, WA) nor the Audubon Society of Portland (Portland, OR) differentiate lead poisoning cases between fishing tackle and ammunition,

though the Audubon Society of Portland noted there have been three cases of fishing-related lead toxicity in the last seven years. (See Table 1.)

Table 1. Rehabilitation Centers That Track Lead Poisoning Cases in Animals

Rehabilitation Center	City	Details
UC Davis Veterinary Medicine - California Raptor Center	Davis, CA	The facility tracks lead poisoning cases; however, there has not been an instance of lead poisoning from fishing lures/weights. The majority of its cases are due to ingestion of lead from carcasses.
Audubon Society of Portland	Portland, OR	The facility tracks lead levels in the majority of birds it cares for. However, the facility does not differentiate lead poisoning cases between lures and shots. There have only been a handful of lead poisoning cases in the last seven years. Three of those cases were fishing related.
Discovery Bay Wildlife Rescue	Port Townsend, WA	The facility began testing for lead this year. It is unknown whether the lead poisoning is due to fishing lures or lead pellets/shot. Eagles are the most common bird that suffers from lead poisoning.
PAWS Wildlife Center	Seattle, WA	The facility both tests and tracks lead toxicity cases. Lead toxicity is seen infrequently. Trumpeter swans, bald eagles and loons tend to suffer from lead poisoning more than other birds. It is rare to find toxicity caused by fishing gear. Other cases have been caused by birds consuming meat exposed to lead shot. However, there are times where the cause is unknown due to no metal fragments being found in the birds.

Source: California Research Bureau

Wildlife rehabilitation centers often share data with wildlife repositories. One such, the Wildlife Rehabilitation MD,²⁴ is a central repository, where 462 wildlife rehabilitators spanning 46 states and 12 countries can collect, manage and analyze data pertaining to animal patients. Most of the patient entries consist of wildlife animals in temporary care due to being injured, orphaned or sick. The Research Bureau requested a query of this database for instances of lead toxicosis caused by fishing tackle. The query found no pertinent results.²⁵

Angler Activity in the U.S. and California

A national survey of fishing and hunting found that in 2011, 1,674,000 anglers age 16 and older fished in California’s waterways. Of these, 81 percent (1,352,000) fished in freshwater, and 46 percent (775,000) engaged in ocean fishing. In total, there were nearly 24 million days of participation, and over 21 million trips.²⁶ See Table 2.

National survey results show that the number of anglers active in California, and the intensity of recreational fishing in the state, have

²⁴ <https://www.wrmd.org/>

²⁵ Correspondence with California Wildlife Center staff, Aug. 9, 2018.

²⁶ U.S. Fish & Wildlife Service, *National Survey of Fishing, Hunting and Wildlife-Associated Recreation, 2011 — California*. Available at <https://www.census.gov/library/publications/2014/demo/fhw-11-nat.html>

declined since the mid-1990s. In 1996, 10 percent of Californians over the age of 16 years participated in recreational fishing (without also hunting), compared to 13 percent of the national population. By 2011, only 5 percent of Californians participated in fishing activities, compared to 10 percent of the population

nationally. The total number of anglers active in California declined from 2,722,000 in 1996 to 1,674,000 in 2011; at the same time, the number of freshwater anglers active in California declined from 2,175,000 to 1,352,000.²⁷

Table 2. Fishing in California, 2011

Type of fishing	Participants		Days of participation		Trips	
	Number (000s)	Percent	Number (000s)	Percent	Number (000s)	Percent
Total, all fishing	1,674	100	23,754	100	21,497	100
Freshwater	1,352	81	17,382	73	15,059	70
Saltwater	775	46	7,193	30	6,438	30

Source: U.S. Fish & Wildlife Service. Percentages do not add up to 100 due to multiple responses.

California Department of Fish and Wildlife annual statistics regarding the number of fishing licenses issued annually similarly points to a decline in recreational and sport fishing in California.²⁸ Since the mid-1990s, the number of fishing licenses issued in California has declined by about 20 percent, from 2,155,899 in 1995 to 1,729,424 in 2017. The number of second rod stamps, which permit an angler to fish with two rods or lines in most inland waters, rose slightly, while the number of lifetime licenses did not change appreciably (See Figure 2). Although data for license issuance suggests a smaller decline in the number of anglers than the National Survey, it also reveals substantial changes in the kinds of licenses that anglers in California purchased. Between 1995 and 2017,

the proportion of temporary licenses increased from 22.5 percent to 38.6 percent of all licenses issued, which would suggest that an increasing percentage of anglers in California were fishing less frequently than previously.²⁹ Overall, the number of days of fishing participation in California declined by 16.3 percent between 1991 and 2011.

²⁷ U.S. Fish & Wildlife Service, *National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, 1996-2011*. This survey, carried out every five years by the U.S. Fish and Wildlife Service and the U.S. Census Bureau, provides an estimate for the number of anglers active in California and their expenditure on fishing equipment. The national survey also allows for a comparison of angling participation in California with national levels of recreational fishing activity. Because the national survey recently

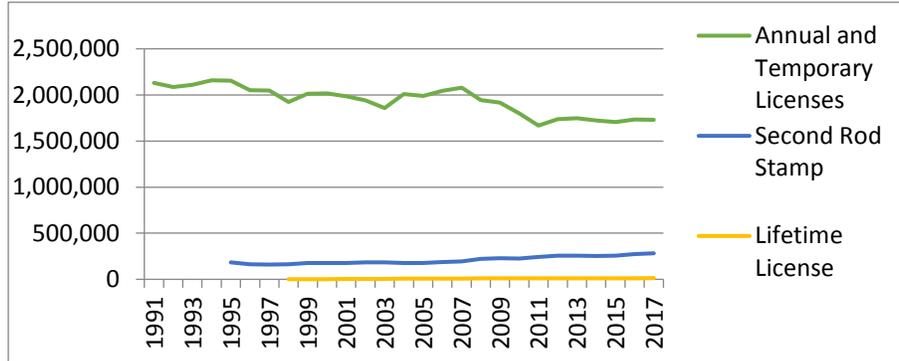
changed its methodology, state-level survey information is only available to 2011.

²⁸ California Department of Fish and Wildlife releases annual statistics on the issuance of fishing licenses and on the different kinds of licenses issued — temporary, annual and lifetime.

²⁹ California Department of Fish and Wildlife, License Statistics.

<https://www.wildlife.ca.gov/Licensing/Statistics>

Figure 2. Total Number of Fishing Licenses Issued in California, 1991-2017



Source: California Department of Fish and Wildlife, License Statistics, Sport Fishing Licenses

Though the number of anglers may have declined over the years, the amount spent on fishing equipment per angler has risen. In 1996, anglers spent over \$77 million on lures, hooks and sinkers. In 2011, the total amount was

nearly \$79 million. Though this is not a large increase, due to the decrease in number of anglers, the average annual amount per angler rose from \$28 to \$45. See Table 3.

Table 3. Expenditures in California on Fishing Equipment, 1996-2011

	1996		2001		2006		2011	
	\$ Amount (000s)	Average \$ per angler	\$ Amount (000s)	Average \$ per angler	\$ Amount (000s)	Average \$ per angler	\$ Amount (000s)	Average \$ per angler
Fishing equipment, total	450,807	163	459,202	165	326,982	182	320,577	182
Lures, hooks, sinkers, etc.	77,254	28	73,831	30	59,528	34	78,835	45

Source: U.S. Fish & Wildlife Service

Lead Sinkers Lost

Fishing sinkers and jigs may be lost in the environment when they snag on underwater obstacles, fall off of – or are cut from – fishing lines in water, or when they are dropped on land. Though no California-specific estimates exist, the U.S. Fish and Wildlife Service’s national survey of wildlife recreation estimated

in 2009 that 6,000 to 10,000 tons of lead are released into the environment by hunters and anglers each year, though this figure does not differentiate between lead ammunition and

lead fishing sinkers.³⁰ A 2003 report published by the Canadian Wildlife Service estimated that in the United States, lost or discarded fishing sinkers and jigs introduce approximately 500 metric tons of lead into the environment annually.³¹

Researchers have also attempted a number of ways to estimate the number of sinkers lost per hour of fishing in the United States. Adam Duerr, a scientist affiliated with the U.S. Geological Survey, attempted to quantify the abundance of fishing tackle along shorelines and lake bottoms in order to determine the rate at which anglers lose tackle. Between 1996 and 1997, Duerr's team visited 15 sites in 12 states, where waterbirds had died from ingestion of lead sinkers. At these sites, shorelines and lake bottoms were sampled by various means, including metal detectors. The team also interviewed over 800 anglers by means of a creel census (a survey of anglers conducted at the water site). Based on the survey, it was estimated that the rate of lost sinkers for all sites combined was .18 sinkers per hour spent fishing. At this rate, each angler would have lost about 1 sinker for every 6 hours spent fishing. The authors did not differentiate between sinkers made of lead and of non-lead materials.³²

In another project, researchers with the Minnesota Department of Natural Resources estimated fishing tackle loss in five large lake

fisheries. In 2004, a total of 6,489 angler parties were interviewed for tackle loss by means of a creel census. On average over the five surveys, the vast majority of anglers reported losing no lures, sinkers, or other tackle in the lakes. The researchers found the mean loss rate was only .0081 per hour for large sinkers.³³

In comparing the Minnesota results to those of Duerr's team, Radomski, et al. note that the difference might be a question of type of fishing. Duerr's team searched for tackle along the shoreline, and also interviewed anglers who fish the shoreline, while the Minnesota interviews were conducted with anglers who had been fishing on the water. "[I]t is conceivable that shore anglers have greater opportunity for tackle loss because of the presence of rocks, trees, and aquatic vegetation along the shore and, in many cases, the inability to move close to the snagged location."³⁴

Conclusion

While the research is clear that lead-based fishing sinkers, jigs and other tackle are dangerous to animals that ingest them or become ensnared, there is not enough published research or data reported by wildlife rehabilitation centers at this time to conclude that the rate of ingestion of lead-based fishing tackle poses a threat on a population level to any specific species. This may be because lead ingestion is not occurring frequently enough to

³⁰ U.S. Fish and Wildlife Service (2018) 2016 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. https://wsfrprograms.fws.gov/subpages/nationalsurvey/nat_survey2016.pdf

³¹ Scheuhammer, A.M., et al. (2003)

³² Duerr, A.E. and DeStefano, S. (1999) Abundance of Lost and Discarded Fishing Tackle and Implications for Waterbird Populations in the United States. M.Sc. thesis, School of Renewable Natural Resources, University of Arizona, Tucson. 88 p.

https://repository.arizona.edu/bitstream/handle/10150/278698/azu_td_1396508_sip1_m.pdf?sequence=1&isAllowed=y

³³ Radomski, P., et al. (2006) Estimates of Tackle Loss for Five Minnesota Walleye Fisheries. North American Journal of Fisheries Management, vol. 26, pp. 206-212.

https://www.researchgate.net/publication/252758158_Estimates_of_Tackle_Loss_for_Five_Minnesota_Walleye_Fisheries

³⁴ Radomski, P., et al. (2006)

identify outcomes, or it may be the result of gaps in research. More research is needed in three particular areas:

Ingestion rates

Select California wildlife rehabilitation centers have examined birds that ingested fishing tackle, and a large-scale California study analyzed cases of birds that ingested or were ensnared by fishing tackle. Though the study did not distinguish between lead and non-lead tackle, it does lend itself to a larger discussion about ingestion rates. Few wildlife rehabilitation centers reported cases of fishing tackle ingestion. It is unknown how widespread the occurrence is; it is possible that more occurrences happen in the wild than are discovered and reported by humans.

Number of lead toxicity cases

It is unclear how widespread the occurrence is of lead toxicity from fishing tackle in birds, amphibians, and mammals in California. Few wildlife rehabilitation centers reported having seen cases of lead toxicity due to fishing tackle. However, rehabilitation centers only know about the cases that are found. It is possible that more occurrences happen in the wild than are discovered and reported. It is also possible that occurrences happen more frequently in or near particular waterways.

Wildlife rehabilitation centers in California, Oregon, Washington and British Columbia do not generally test for lead poisoning in the rescued animals brought in for treatment. Of the centers that have seen verified lead poisoning cases, few engage in systematic tracking. Wildlife repositories collect data from rehabilitation centers and other types of veterinary practices, and are in a position to track lead toxicosis cases from lead fishing tackle. The Research Bureau made a query to

one wildlife data repository and found no results. Other wildlife repositories could have further information to share.

Lost fishing tackle

Though the U.S. Fish & Wildlife Service's survey found that anglers spent \$78.8 million on hooks, lines and sinkers for fishing in California, and the Radomski and Duerr research provides some likely loss estimates per hour fishing, more information is needed to reliably estimate how much lead tackle is lost in the state's waterways, including: the number of tons of fishing tackle purchased each year, whether from stores or online, whether estimates from other states are valid here, and whether California anglers are using a lower percentage of lead tackle due to Proposition 65 warnings or educational materials.

It is important to bear in mind that whatever the rate of loss is, it is cumulative. Lead objects can take many years to degrade in water; the more sinkers and jigs are lost or discarded each year, the more will potentially be a threat to the environment.

Appendix

Wildlife Rehabilitation Centers along the Pacific Coast Surveyed for Cases of Lead Toxicosis Due to Fishing Tackle

Wildlife Rehabilitation Center	City	State / Province	Track cases of lead toxicity?	Details
California Department of Fish and Wildlife – Wildlife Investigations Laboratory	Rancho Cordova	CA	No	The lab investigates wildlife mortality and does test birds for lead exposure when indicated. There have not been any lead poisoning cases in waterbirds that have been known to be caused by fishing lures/weights. Part of the reason for this may be that the death of the waterbird may go unnoticed by the property owner or unreported to the lab. The lab is most likely to receive reports of mortality when multiple birds are found dead over a short period of time.
California Wildlife Center	Malibu	CA	No	This facility does not receive many lead toxicosis cases.
Gold County Wildlife Rescue	Auburn	CA	No	This facility is not able to test for lead poisoning. Any suspected cases are sent to California Foundation for Birds of Prey.
Lindsay Wildlife Experience	Walnut Creek	CA	No	The facility does not conduct blood tests for lead poisoning. Rather they take radiographs, stabilize the bird, and then send them to International Bird Rescue.
Los Angeles County Department of Public Health	Baldwin Park	CA	No	The facility does not have any information regarding lead-poisoned birds from fishing lures/weights.
Ojai Raptor Center	Oak View	CA	No	The facility does not track suspected lead poisoning cases. Fishing lure lead is not usually the culprit for any lead-poisoned birds the facility comes across.
Orange County Bird of Prey Center	Lake Forest	CA	No	The facility gets very few birds that ingested fish/fishing lures. The representative forwarded the inquiry to a local field biologist. The biologist does not collect this data either, and informed the Research Bureau that it is difficult to trace back lead poisoning to fishing gear specifically; the poisoning could have very well come from eating fish.
Pasadena Humane Society & SPCA	Pasadena	CA	No	The facility is mainly a triage and transport facility and does not test for lead poisoning. Any animals that are sent for testing are through the Los Angeles County Department of Health.

Wildlife Rehabilitation Center	City	State / Province	Track cases of lead toxicity?	Details
Shasta Wildlife Rescue and Rehabilitations, Inc.	Shasta County	CA	No	The facility has not encountered a lead-poisoned bird despite being in close proximity to Sacramento River and Lake Shasta.
South Bay Wildlife Rehab	Rancho Palos Verdes	CA	No	The facility has never come across lead poison cases. Additionally, the facility passed its care of water birds to International Bird Rescue in San Pedro.
Stanislaus Wildlife Care Center	Stanislaus County	CA	No	X-rays and blood work would only be conducted if there was reason to believe that the bird swallowed a fishing hook. The few times they have been able to identify lead poisoning, x-rays showed small bits of metal in the stomach, too small to tell what the object originally was. Most of the time, lead poisoning is not obvious.
The Bird Rescue Center	Sonoma County	CA	No	They do receive a few lead-toxic birds each fall, but do not collect data. The birds they typically come across with this issue are vultures who have ingested small lead pellets/pieces from game animals.
The Nature of Wildworks	Topanga	CA	No	No further details given
The SPCA for Monterey County	Monterey County	CA	No	The facility does not perform blood panels to check for lead poisoning on its seabirds. They only perform that test on turkey vultures and eagles.
Tri County Wildlife Care	Jackson	CA	No	The facility only has one confirmed lead poisoning case in the last 5 years and it was a bald eagle, which had a hook lodged in its esophagus. The facility does not ordinarily test for lead poisoning.
UC Davis Veterinary Medicine – California Raptor Center	Davis	CA	Yes	The facility does keep track of its lead poisoning cases; however, there has not been an instance of lead poisoning from fishing lures/weights. The majority of its cases are due to ingestion of lead from carcasses.
Wetlands & Wildlife Care Center	Huntington Beach	CA	No	The facility does get a large number of birds that have fishing line, hook and lure issues.
Wild Wings of California	San Dimas	CA	No	This facility is not set up to rehabilitate aquatic birds.
Wildcare	San Rafael	CA	No	Birds who test positive for lead poisoning are mainly getting it from shot rather than fishing equipment. If the facility conducts testing, it is mainly for swans, geese and vultures. They do not receive many animals with lead poisoning.
Wildlife Care Association of Sacramento	Sacramento	CA	No	This facility primarily receives songbirds, so there is not lead poisoning data to keep track of.
Wildlife Center of Silicon Valley	San Jose	CA	No	The facility has not received any patients with symptoms that would lead it to believe the animal suffered from lead poisoning.
Yggdrasil Urban Wildlife Rescue	San Francisco	CA	No	No further details given

Wildlife Rehabilitation Center	City	State / Province	Track cases of lead toxicity?	Details
Audubon Society of Portland	Portland	OR	Yes	The facility tracks lead levels in the majority of birds it cares for. However, the facility does not differentiate lead poisoning cases between lures and shots. There have only been a handful of lead poisoning cases in the last seven years. Approximately three of those cases were fishing related.
Badger Run Wildlife Rehab	Klamath Falls	OR	No	This facility lead tests every eagle that comes into its care, but does not have data relating to lead fishing tackle. There has not been an instance where a lead-positive bird has been shown to have a lead lure or sinker associated with the lead exposure. Lead testing has only been conducted at this facility for the past three years.
Cascade Raptor Center	Eugene	OR	No	The facility has seen some lead poisoning in its birds, but it is rarely from lead sinkers. They also receive birds that are tangled in fishing line with sinkers included, but there has not been an instance where a bird swallowed the sinker. Lead poisoning is typically from lead shot.
Native Bird Care of Sisters	Sisters	OR	No	Species who suffer from lead poisoning are more likely to be from hunting-related instances. The contact person stated there are huge issues with fishing lures poisoning birds in the Northwest, specifically near the Yukon River and Brandt.
Rowena Wildlife Center	The Dalles	OR	No	The waterfowl that they receive are either hit by car or gunshot.
Sunriver Nature Center & Observatory	Sunriver	OR	No	No further details given
Wildlife Center of the North Coast	Astoria	OR	No	If the bird is found to be suffering from lead poisoning, it cannot be determined where or how the poisoning occurred. The center typically receives the animals after the lead objects have already left their bodies.
Ellensburg Animal Hospital	Ellensburg	WA	No	The majority of the facility's wild bird poisonings are raptors with no radiographically visible lead foreign bodies. The hospital commonly comes across eagles or ospreys that are intoxicated by eating ducks carrying high levels of lead from lead shot. The doctor also claims that lead fishing weights could be another likely source of the secondary exposure. In addition, there is concern with lead content from fish due to water lead levels.
For Heaven's Sake Wildlife Rescue & Rehabilitation	Rochester	WA	No	This facility is no longer doing wildlife rescue.

Wildlife Rehabilitation Center	City	State / Province	Track cases of lead toxicity?	Details
PAWS Wildlife Center	Lynnwood	WA	Yes	This facility both tests and tracks lead toxicity cases. Lead toxicity is seen infrequently. Trumpeter swans, bald eagles and loons tend to suffer from lead poisoning more often than other birds. It is rare to find toxicity caused by fishing gear. Other cases have been caused by birds consuming meat exposed to lead shot. However, there are times where the cause is unknown due to no metal fragments being found in the birds.
Raindancer Wild Bird Rescue	Olympia	WA	Yes	This facility recently acquired a lead meter and has started to test birds that it receives. The cases the facility comes across pertaining to lead poisoning have been caused by ingestion of lead shot.
Useless Bay Animal Clinic, Inc.	Freeland	WA	No	This facility does not keep records, but the person of contact claims that he has seen one to two lead poisoning cases in the span of 30 years.
Washington State University - Washington Animal Disease Diagnostic Laboratory	Pullman	WA	No	No further details given
Washington State University College of Veterinary Medicine	Pullman	WA	No	The facility receives a lot of birds with lead poisoning due to close proximity to an EPA Superfund site, the mining district of Kellogg, Idaho, and the Coeur d'Alene River drainage and lake. This area has decades of mining and smelting silver/zinc that produces a lot of lead contamination in the region. It is also the location for bald eagle layovers in winter where they feast on salmon from the lake. The majority of lead poisoning cases the facility comes across is ingestion of smaller pieces of lead rather than one large piece (such as a hook).
Whatcom Humane Society	Bellingham	WA	No	No further details given
Wolf Hollow Wildlife Rehabilitation Center	Friday Hollow	WA	No	The facility does come across birds with lead poisoning, but it is due to ingesting lead shot. When the nearby fields flood in the winter, there is an increase in swans ingesting lead shot and suffering from lead poisoning. At the same time, bald eagles suffer from secondary poisoning due to eating the dead swans, ducks and geese. There has not been an instance where a bird has shown lead poisoning symptoms due to fishing gear.
Woodland Park Zoo	Seattle	WA	No	The birds at this facility do not have access to lures/weights.

Wildlife Rehabilitation Center	City	State / Province	Track cases of lead toxicity?	Details
BC Conservation Data Centre	Victoria	British Columbia	No	No further details given
Ministry of Forests, Lands, Natural Resource Operations and Rural Development – Wildlife and Habitat Branch	Nanaimo	British Columbia	No	There has been no evidence of fishing weights being ingested as a diagnosis in wildlife pathology results. Person of contact consulted with the branch's senior avian pathologist and federal agency work on migratory waterfowl and seabirds. They have determined that it is extremely rare to find lure ingestion as the cause of death.
Ministry of Environment and Climate Change Strategy	Victoria	British Columbia	No	No further details given
Natural Resource Operations/Cariboo Natural Resource Region	Williams Lake	British Columbia	No	Neither wildlife centers nor fisheries in the region keeps track of this data. It is rare to come across waterfowl with a lure snagged on it. It is unknown whether or not the waterfowl are actually swallowing the hooks.

Source: California Research Bureau