WRITTEN TESTIMONY OF

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BEFORE THE UNITED STATES HOUSE NATURAL RESOURCES COMMITTEE
SUBCOMMITTEE ON THE WATER, OCEANS, AND WILDLIFE

Oversight hearing on *DDT Dumping Off the Southern California Coast: Ecological Impacts, Scientific Needs, and Next Steps.*
Tuesday, June 8th 2021

**Amended on Friday, June 20th 2021 in response to a budget request.**

Chair Huffman, Ranking Member Bentz, and Subcommittee members, I am grateful for the opportunity to submit this written testimony concerning the issue of DDT Dumping off the Southern California Coast: Ecological Impacts, Scientific Needs and Next Steps. Because of the complexity of this issue, I sought input for this testimony from the broad range of relevant expertise represented at Scripps Institution of Oceanography, some of which has already provided new insights into the issue at hand.

I am a marine scientist with expertise in the biogeochemistry of the Southern California coastal ocean. My research examines chemical, physical and biological connections in the California Current region and as such I participate in both the California Cooperative Oceanic Fisheries Investigation Survey program (the longest running ocean ecosystem timeseries in the world) and the NSF supported California Current Long-Term Ecological Research Program (the second oceanic site of the 28-site LTER network that encompasses the US, Panama and Antarctica). Together, these research and monitoring programs use a combination of advanced observational technologies and sample collection methods to study regional ocean circulation, nutrient distributions, ocean carbon, and biota, to better understand how our coastal environment responds to perturbations such as climate change, human impacts, and environmental disasters. In addition, for 5 years, I co-Directed the Scripps Center for Oceans and Human Health (funded by NIEHS and NSF) and in this capacity I contributed to the study of the distribution of natural and man-made chlorine and bromine containing compounds accumulating in top predators, specifically bottlenose dolphins, in the Southern California coastal ocean. In this work we capitalized on advanced tools to provide an unprecedented snapshot of the chemical contamination in marine organisms.

I have a B.A in both Chemistry and Philosophy (1993), with a concentration in Organic Chemistry, from Mount Holyoke College (South Hadley, MA), and a PhD in Oceanography from the Joint Program between the Massachusetts Institute of Technology and the Woods Hole Oceanographic Institution (1999). I have been a Professor at UC San Diego, Scripps Institution of Oceanography since 2000.

<u>Introduction</u>
Southern California's coastal ocean hosts a productive fisheries economy, is home to numerous, thriving and protected ecosystems, and tourists flock to its cities and coastlines throughout the year. In addition, multiple high-profile educational institutions, including the UC and Cal State Institutions, along with state scientists and policy makers, political representatives, concerned stakeholders and ordinary citizens, have long been engaged in studying and protecting this system in the face of increasing human use and climate-related impacts.

Human population growth, urbanization, and activities related to resource exploration and industrial manufacturing have significantly impacted Southern California's coastal ocean. In addition, its ocean ecosystems and circulation patterns are impacted by natural climate variability including El Niño and La Niña events, and rising incidences of marine heatwaves sometimes leading to widespread toxic algal blooms. At the same time, its bottom waters, including at the bottom of San Pedro basin, are experiencing long term changes (such as increasing oxygen depletion and ocean acidification) triggered by increasing greenhouse gases in the atmosphere.

It is against this backdrop that the rediscovery of the permitted dumping site for ~500,000 fifty-five gallon drums filled with petrochemicals and industrial waste, just 12 miles off the coast of California between Los Angeles and Catalina Island, must be considered. Based on a 1980s report, some of these barrels contain the waste associated with manufacturing the pesticide dichlorodiphenyltrichloroethane (DDT), consistent with the detection of DDT in sediments at the dump site. This site sits in 3000 feet of ocean water, making it unique in terms of an industrial chemical pollution site, and offers a challenge in terms of access. In addition, because the DDT-suite of compounds, >40 in all, and some petroleum related compounds, enter at the base of the marine food web, most likely through the ingestion of sediment particles coated in these "sticky" molecules, multiple components of the marine food web as well as humans who consume locally sourced seafood are at risk. The marine organisms most at risk of adverse health impacts are marine mammals, who feed at the top of the coastal California food web and accumulate these compounds in their fatty tissue. Indeed, the DDT suite of compounds is the most prevalent man-made contaminant in California marine mammals.

In the following pages I will briefly discuss what is known about the dump site so far and identify how best to 1) assess the potential mobility of the waste, 2) characterize the toxin transfer to all components of the marine food web along the California coast (from benthic inhabitants living in the local sediment to apex, pelagic predators that traverse the entire California coast), and 3) assess potential risks to human exposure resulting from the pollutant content of the barrels and local sediments.

Overall, given the complexity of the problem and its diverse impacts, an integrated effort that includes multidisciplinary scientists with cutting edge technology, multiple federal funding agencies (cross-agency), and various state and county agencies and stakeholders must be engaged, organized and managed to ensure high quality scientific results are produced and disseminated to the relevant policy makers and stakeholders. Furthermore, a discussion should take place to establish how and whether this area should be managed going forward to ensure that sampling is coordinated and safe, and sediments and waste containers are not disturbed until a mitigation/restoration strategy is formulated.

## Background and Overview

The deep ocean basins between Los Angeles and Catalina, Santa Monica (SMB) and San Pedro (SPB) basins, are historical dump sites for various hazardous industrial wastes including petrochemicals, and the pesticide dichlorodiphenyltrichloroethane (DDT), which was banned for domestic use in 1972 due to its well documented toxic effects on animals and humans. The largest manufacturer of DDT in the world, Montrose Chemical Corporation, produced the toxin in a dedicated Los Angeles County plant between 1947-1982.

Disparate survey efforts in the last decade confirmed high concentrations of these chemical compounds in seabed sediments, with very recent survey data collected by Scripps, in partnership with NOAA, revealing the presence of >27,000 dumped barrels extending across a region much larger than originally anticipated, and extending beyond the permitted dumping region. The orientation of the barrels, their location, and, in some cases, evidence that barrels were altered to ensure rapid sinking, all point to purposeful and coordinated dumping.

There is unfinished business at this dump site. A thorough and organized scientific assessment of the dump site is required to understand the environmental and human health impacts of the dumping, including: a) the scope and condition of the dump site b) the processes that transport and alter composition of the dumped chemicals and c) the biological pathways that lead to human exposure. This effort will inform future risk assessments, identify long term monitoring requirements, and support the development of remediation strategies. Furthermore, there is uncertainty regarding intensity of dumping at a second, nearby dumpsite 11 nautical miles away. Both dump sites are referenced in historical documents that outline the use of the San Pedro Basin for industrial waste disposal.

Current Knowledge

DDT exposure has been linked to increased risks of cancer, premature births, developmental abnormalities, and neurological diseases in humans and animals. Additionally, since DDT is an extremely stable chemical and not easily broken down in metabolic processes, exposure can be passed on through multiple links in the food web, and through multiple generations. Living microorganisms and detritus that absorbs DDT may in turn expose the fish that eat them, which in turn expose birds, sea lions, and humans. A recent study by researchers at UC Davis and the Public Health Institute in Oakland found adverse health effects in women whose maternal grandmothers were exposed to DDT.

DDT pollution along the California coast remains prevalent even 50 years after the EPA's ban on its use. Studies by scientists from San Diego State University and Scripps Institution of Oceanography reveal dolphin populations in Southern California to have higher DDT burdens than any other equivalent dolphin population. Furthermore, one in four adult male California Sea Lions have cancer, which is also associated with high burdens of DDT and other compounds that could directly impact cancer or increase susceptibility via suppression of the immune system. Critically endangered California condors, are exhibiting reproductive problems associated with increased DDT body burden, brought about through scavenging marine mammal carcasses. While DDT is the best-known member of its industrial formulation, tissues from California's contaminated marine animals reveal 45 related compounds including previously unrecognized chemicals with uncertain toxicities and behaviors.

The Palos Verdes Shelf has long been considered the primary source of the DDT pollution plaguing the region and was the subject of an EPA Superfund Cleanup site. However, many unknowns remain regarding the role that offshore dumping of waste might play in the overall budget of these highly toxic compounds in our marine ecosystem. Direct knowledge of this issue stems from three primary sources: a 1985 report by the California Regional Water Quality Control Board that summarized data reports and permit records of dumping activities indicating that up to 500,000 barrels were discarded, at a rate of approximately 1 million gallons of waste per year between 1947 and 1961 (Chartrand et al., 1985), which amounts to a total of 300-700 tons of DDT (Kivenson et al., 2019) and is comparable in magnitude to the accumulation of DDT on the Palos Verdes Shelf; studies published by UC Santa Barbara following a 2011 and 2013 survey identifying about 60 containers of waste on the seafloor (e.g., Kivenson et al., 2019), providing insight to the dumping activities and indicating that offshore dumping is the primary source of the DDT family of compounds to an area of 3,000 square kilometers; and a study by Scripps Institution of Oceanography in 2021, identifying over 27,000 likely barrels in a search area of 150 square kilometers, and which also indicates dumping may have occurred outside of the deep basin and extended into the steep terrain leading onto the coastal shelves. While these studies have begun to reveal the extent of the problem, fundamental science gaps remain to inform a response strategy.

Knowledge Gaps

We have identified key gaps in our current knowledge of this issue summarized here as questions to guide four overarching themes:

1. What is the scale, condition, and contents of the dump site?
2. What key environmental processes transport and transform waste materials?
3. What are the past, current and future effects of the waste on marine ecosystems and human health?
4. What methods can be applied to minimize risk, restore damage and remediate contamination?

Our Approach

By assembling a multidisciplinary research team consisting of scientists from UC San Diego, Scripps Oceanography, San Diego State University, UC Santa Barbara, and others, we propose scientific efforts around these themes:

(1.) Toward identifying the ***scale, condition, and contents*** of the dump site, we will quantify the number and location of barrels present, identify dredge spoil mounds or other regions where non-containerized waste may have been dumped, assess the condition of the waste containers, develop an approach to ascertain their complete chemical contents, map the extent to which contamination has escaped the barrels, and assess the potential of barrels to lose integrity in the future.

(2.) Toward identifying the ***transport and transformation processes*** of waste materials we will investigate the underlying processes that couple biology, chemistry, physics and geology in this setting. We will assess the potential role of benthic animals releasing contaminants to the overlying waters, the role of ocean microbes in degrading or adapting to the contaminants, the potential for long term burial of wastes, physical transport of material by ocean currents, and the extent to which these processes compromise the integrity of the barrels and cause leakage of their contents.

(3.) Toward identifying the ***current and future effects of the waste on marine ecosystems and humans*** we will identify diagnostic chemical fingerprints and water-column transport mechanisms of toxins, ascertain contaminant distributions and bio-accumulation in key animals throughout the food web and toxin transport with time, and assess the potential risks to ecosystems and human health.

(4.) Toward assessing methods for ***minimizing risk, restoring damage and remediating contamination*** we will engage in a synthesis of the scientific findings following the completion of our efforts to address the first three themes. This synthesis effort will serve to inform the subsequent decision process regarding this issue.

We envision this interdisciplinary science team will conduct a four-year effort whose output will inform government efforts to consider remediation strategies. Synthesis from the studies will be directed towards key questions as outlined below:

### (1.) Characterization:

Effective management, remediation, and scientific actions will require complete mapping of the location and conditions of dumped materials within the region. A recently completed survey mapped the site with sidescan sonar, and identified more than 27,000 barrel targets, and a total of over 100,000 pieces of debris. Despite these large numbers, mapping of the full extent of the dump site remains to be completed. While there are unique elements to the dump site that present technical challenges, they can be overcome with modern and emerging technologies. Overall, understanding the chemical complexity of the waste disposed in these areas and the risk of release into the environment, is crucial for understanding impacts on the food web and risks to human health as the propensity of different chemicals to move through the environment and biota varies.

Key questions include:

1. How many barrels are present and where are they located?
2. What is the composition of the chemical mixtures in these barrels?
3. What is the visual integrity status of the barrels?
4. How much material has escaped containment?
5. Can insights from industrial chemical engineering better inform the composition of the wastes?

(2.) Processes:
Effective management, remediation, and scientific actions demands a comprehensive accounting of how containerized contaminants are entering the surrounding environment and being transformed and transport by physical, chemical and biological processes. The unique sedimentary conditions and bottom water chemistry of these deep sites have can potentially compromise the integrity of the containerized waste and influence the local biotic structure, which in turn could influence redistribution of escaped toxins into the overlying waters. The mixed chemical waste barrels rest on (and have leaked into) deep-water sediments inhabited by a host of invertebrates who can ingest and transport these compounds and also transfer them to water column food webs where top predators include fish and mammals. Finally, microbial communities with their fast regeneration times have had thousands of generations to adapt to this toxic environment and may provide insights into remediation strategies. To address these complex and disparate processes, a multidisciplinary approach must be taken and the relevant expertise is well represented at the Scripps Institution of Oceanography. Key questions include:

1. To what extent are environmental processes diminishing the containment integrity of barrels?
2. How are local sedimentation rates and processes and geology impacting the barrels and escaped contaminants?
3. How are bottom currents and other physical mixing processes mobilizing chemicals including organic contaminants such as DDT and petroleum waste into the water above sediments.
4. To what extent does water depth and oxygen availability structure the conditions around each barrel?
5. To what extent are the indigenous microbial communities degrading the contaminants and into what chemical transformation products?
6. To what extent are burrowing animals transporting buried contaminants to the surface of the sediment and the water column?

(3.) Ecosystems and Health:
California commercial and recreational fisheries produce billions in economic benefit annually. Mounting evidence of a vast field of contaminant laced industrial sludge is likely to disrupt this economy and the fishing communities that rely on it, as consumers shy away from the region's seafood products. Our efforts to quantify the penetration, if any, of dumpsite associated chemicals into marine food webs will aid in efforts to preserve the economic value of California's fisheries by guiding fishing practices that generate safe and healthy seafood products. Scripps Oceanography maintains the world's largest marine specimen collection from the California Current Ecosystem, including extensive specimens from California's iconic Sardine fishery. Preserved marine animals in this collection date back to the 1930s (prior to the barrel dumping), providing an unparalleled opportunity to monitor DDT and other industrial contaminants in the California Current fishes prior to and following the onset of containerized waste

dumping. Given that the sources of persistent organic pollutants such as DDT, to the region are numerous, and that top predators amass 100s of anthropogenic pollutants, it is crucial that we robustly trace the containerized waste derived contaminants into the benthic and water column food web, including in sportfish and other living marine resources that humans consume. Furthermore, the evidence from previous studies identified >45 DDT degradation products as well as contaminants introduced during the manufacturing process, but the diversity in their bioactivity remains unknown and may be of greater concern than the well documented adverse health impacts of DDT. Benthic fauna attached to, beneath and surrounding the containerized waster could be a key link to water column food webs, and their distribution and function may also be impacted by the presence of the waste and its composition, including DDT content. Key questions include:

1. Can we develop diagnostic chemical fingerprints to distinguish the entry of contaminants from the deep dumpsite into the local marine ecosystem?
2. Is the seafloor animal community structure and/or function impacted by the barrel contamination?
3. Are certain seafloor animals a key link in initiating the transfer and biomagnification of contaminants into the food web?
4. To what extent and by what mechanisms are the contaminants transported throughout the marine food web?
5. Do certain contaminants or their transformation products pose a greater concern because of relatively high potential toxicity?
6. Can we predict the food web biomagnification potential of novel contaminant degradation products?
7. Can we ascertain the time history of DDT in the local food web using archived marine fauna?
8. What is the level of current and potential future human toxin exposure via fish and fisheries, based on the answers to the research questions outlined above?

(4.) Synthesis and Risk Assessment:
Assessment of the extent, composition, and impacts of chemical waste dumping will quantify the penetration of DDT and other contaminants into local marine ecosystems. Should the initial assessment find little penetration into the food web, it will aid in efforts to preserve the economic value of California's fisheries and tourist destinations which have already seen reduced demand due to consumer apprehension. Should the assessment find that the dumped waste has penetrated marine food webs, remediation efforts will need to be undertaken in order to reduce widespread exposure to toxic chemicals such as the DDT-suite of compounds. Either course of action would benefit southern California’s fishing and tourism industries, which produce billions of dollars of economic benefit to the state annually. Key questions include:

1. To what extent do the results from the above efforts inform the decision process for this issue?
2. What overall risk does this newly identified contamination pose to wildlife and humans?
3. What guidance can we provide to ensure the continued safe use of California's marine resources including future use of this region for aquaculture, for example.
4. Disturbing bottom sediments in the basin could mobilize the chemical and industrial waste into deep waters so how do permitting agencies, like those who permit deep sea ocean cable laying, obtain the information they need for safe operation?
5. What key impediments need to be addressed toward identifying resolution?

In closing, new technologies provide us with the opportunity to more accurately characterize and document ecosystem and human health risks posed by the rediscovered industrial and chemical waste dumpsite in the San Pedro Basin. Such an assessment will provide the understanding necessary to inform discussions of remediation, restoration, and future use. Due to its close proximity to shore, this site provides us with an opportunity to launch the focused, multidisciplinary effort that is necessary to delineate the spatial extent, chemical complexity, transport, and risk to ecosystem and human health of this site, while also developing technology and a research framework that could benefit studies of other deep-water dumpsites worldwide

## $9.5 million for Southern California deep ocean dumpsite characterization, monitoring, and research by UC San Diego Scripps Institution of Oceanography

Recently published papers and a wide-area survey of the Southern California mid-channel, ocean DDT dump site requires interdisciplinary assessment of extent and scope of contaminant impacts, and work to assess mitigation strategies. Project will 1) fully characterize the extent of the barrel field (including toxin sampling), 2) identify the toxin "fingerprint" contained in the barrels, 3) survey the barrel-derived toxin loads of animals on the seafloor on/near the site, and 4) assess the extent human exposure to toxins via fish and fisheries. This latter effort aims to mitigate any potential loss of public confidence in California's ocean products and economy. Finally, we will explore the potential for microbiological neutralization of toxins on the seafloor, with the goal of formulating an effective remediation strategy moving forward. We anticipate that the combined efforts outlined below will take place over 4 years (48 months) and present an estimated budget that only covers extramural costs.

### $3 million Site Characterization Plan "Find the Barrels"

Effective management, remediation, and scientific actions will require complete mapping of the location and conditions of dumped materials within the region. A recently completed survey mapped the site with sidescan sonar, and identified more than 27,000 barrel targets, and a total of over 100,000 pieces of debris. Despite these large numbers, mapping of the full extent of the dump site was not completed. While there are unique elements to the dump site which present technical challenges, they can be overcome with modern technology. Those challenges include:

- Water Depth: The site is notionally at 850-900m; and extends beyond readily accessible equipment for protracted dives with both remotely operated vehicles and autonomous underwater vehicles for wide area mapping.
- Terrain adjoining the debris field: The basin in which the presently mapped debris field is located is surrounded by a steep escarpment; both towards Catalina and towards the Palos Verdes Shelf. The presently mapped debris field approaches this region, and the data suggests a continuation of debris may exist across the escarpment, and potentially onto the shallower waters on the shelf. Novel deepwater equipment is needed to continue the mapping across these steep regions.
- Quantity and age of targets: The presently mapped field suggests a large quantity of barrel drums. The present mapping effort resulted in excess of 100,000 debris field targets, with approximately 27,000 of those targets classified as barrels. Assessment of these sites is a big data problem. Continued investment in the research and development of largescale data analytics; leveraging emerging machine learning techniques hold promise for automated assessment of barrel condition. With the precision targeting information now in hand, a pragmatic imaging survey using remotely operated vehicles

and autonomous underwater vehicles to assess the condition of those barrel and document the debris field targets can be conducted. This assessment can be conducted with a variety of modalities of sensing. Targeted imagery collection will be used to train classification models for the broader basin.

A second dump site, located 12 miles to the north west has never been surveyed, but is also referenced in reports which originally raised the issue of historical dumping off the California coast and should be prosecuted with similar approaches.

Data collection to constrain bottom boundary layer mixing and transport, as well as basin scale stratification and transport would support and validate forecasts of the water column transport of dumped material. Current profilers, turbulence sensors, and CTDs would be integrated into the seabed survey vehicles for high-resolution characterization of the bottom boundary layer. A persistent monitoring network, consisting of bottom mounted sensors, would supplement the high-resolution surveys.

**$1.5 million “Fingerprint” Chemical Waste Specific To Deeep Dumpsites.**
Our previous work suggests that the degradation products of the DDT technical-mixture (i.e., the sludge that was packed into barrels or directly released into wastewater) have a distinct fingerprint in the body of burden of Southern California common dolphins. Given that the sources of persistent organic pollutants to the region are numerous, and that top predators amass 100s of these anthropogenic pollutants, it is crucial that we robustly trace the barrel derived contaminants into the water column and food web, including in sportfish and other living marine resources that can influence people’s diets. As such, a foundational component of the early work will be dedicated to isolating sediment material near several barrels using remotely operated vehicles and in the water column directly above barrels (close to sediments) to isolate fine particles suspended in the water column. These samples will be comprehensively chemically analyzed to identify major DDT products as well other persistent industrial and chemical waste that can be traced into sediment- and water column-animals discussed in other paragraphs. A fundamental unknown in terms of tracing contaminants into top predators (fish that eat other fish and live relatively long lives) including sportfish, is the exact pathway of travel through prey. By identifying a barrel chemical fingerprint and following it through local food webs we will demonstrate this chain of transfer. Furthermore, characterizing the fingerprint and carefully quantifying the compounds present will also enable us to identify which compounds are being transferred to top predators. Such an analysis will narrow the suite of compounds that need to be tested for their toxicity. Later ecotoxicological studies can be initiated through collaborations with UCSD Health Sciences, which offers unmatched expertise in this context.

**$1.5 million chemical waster uptake, accumulation, and redistribution by seafloor animals**
The identified barrels rest on (and have leaked into) deep-water sediments inhabited by a host of invertebrates. These animals range in size from microscopic to large and are capable of mixing barrel derived chemicals downward into the sediments, altering microbial communities that degrade these chemicals (e.g., through oxygenation), ingesting and accumulating DDT, its derivatives, other dumped chemicals and transporting these compounds away from the barrels and into the food webs containing fish and mammals. This component will characterize the

benthic fauna attached to, beneath and surrounding the barrels, their vertical distribution in sediments and horizontal distribution relative to the barrels and assess body burden of DDT and derivatives, and examine consequences for health of the seafloor community (by drawing comparisons with more distant assemblages and linking to hydrographic features). Animals will be identified to species level via morphology and DNA sequencing and compared to local background fauna. Voucher samples preserved in various ways will be archived into the Scripps Oceanography Benthic Invertebrate Collection. This work would be done in collaboration with microbiologists, chemists, biologists, and water column ecologists. Collaboration with geochemists to get mixing rates (Pb-210 or Th-234) is also possible. We would also include isotope analyses of sediments and fauna to support investigation of benthic-pelagic coupling to better understand spread via the food web. Work would involve pushcores, scoop samples and video we intend to collect in early Aug. 2021 using the ROV SuBastian aboard the RV Falkor (described below).

### $3 million Maintaining confidence in California's healthy seafood products

California commercial and recreational fisheries produce billions in economic benefit annually. Mounting evidence of a vast barrel field of toxin laced sludge is likely to disrupt this economy and the fishing communities that rely on it, as consumers shy away from the region's seafood products. Our efforts to quantify the penetration of toxins into marine food webs (or, importantly, lack of penetration) will aid in efforts to preserve the economic value of California's fisheries by guiding fishing practices that generate safe and healthy seafood products.

To assess the fate of toxins in the marine food web, and connections to fisheries products, we will measure toxin levels in preserved marine animals in the Scripps Institution of Oceanography collection, dating back to the 1930s (prior to the barrel dumping). Scripps maintains the world's largest marine specimens collection from the California Current Ecosystem, including extensive specimens from California's iconic Sardine fishery. Using these samples, we will describe the progression, in time and space, of barrel toxins in the marine ecosystem. In addition, we will sample and analyze contemporary commercial and recreational catch and assess toxin loads across species and fisheries throughout southern California. Our goal is to scientifically demonstrate the safety of California seafood products, and/or provide guidance to the fishing industry regarding best practices for minimizing the harvest of unsafe seafood, should evidence of such seafood exist.

### $500,000 Microbiological remediation strategies

Microbes are the major contributors to DDT degradation in ocean sediments. Capitalizing on a July 2021 cruise to the San Pedro basin barrel dump site aboard the R/V Falkor ($120,000 in-kind contribution to this proposal), push cores will be collected along transects (starting close and moving away from barrels). Microbial communities will be assessed (16S rRNA sequencing) along 1 cm vertical profiles in these cores (to a depth of 10 cm) and compared to DDX (DDT and associated products) concentrations in the sediments (determined by SDSU/UCSD collaborators) and comparable sites distant from the dump zones. Metagenomic analyses will be used to assess the potential for DDT degradation and determine which taxa are associated with these activities. These studies will provide a method to assess sediment microbial communities for a return to “normalcy” and opportunities to identify microbes that may be useful for bioremediation. Efforts will be made to obtain strains capable of DDT degradation in culture and demonstrate their capacity to metabolize DDT. These studies will be linked to the animal analyses described above and performed in coordination with other investigators studying this problem in the region.