A Clean Up The Lake Report:

Results of the 2020 Lake Tahoe SCUBA-Enabled Litter Cleanup Dives

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Abstract

Littering and litter accumulation is an ongoing global issue. Litter deposited on land is often transported via rivers or wind into estuaries and marine environments, where the litter can accumulate and persist for decades of centuries. Freshwater environments, although relatively less studied, are not exempt from this litter accumulation problem. Similar to marine systems, lakes are topographical low points such that litter deposited in a lake basin is subject to riverine and wind transport into the lake. Other litter accumulation pathways include direct input from boaters and lake-side recreators. While the Tahoe Basin is a closely-managed and protected lake basin, it is not exempt from the global litter problem. Pilot dives in 2019 removed nearly 900 pounds (lbs.) of litter from just 1.2 miles of lake shore. These findings lead to the Clean Up The Lake program, which (CUTL) completed 7.1 miles of cleanup dives along Lake Tahoe's Nevada shorelines. These dives removed 1758 lbs. of litter that were then sorted and weight according to 9 material, and 77 source categories. Litter data show that litter accumulation is correlated with the occurrence of rocky lakebed and the proximity to popular and populated shoreline.

Lake Tahoe's Litter Problem

Litter and the accumulation of litter in natural environments is a persistent global issue (Bergmann et al., 2015; Hoellein et al., 2015; Jambeck et al., 2015; Keep America Beautiful and Action Research, 2009; Maes et al., 2018; Napper et al., 2019.; Schultz and Stein, 2009). A 2009 study found that American roads have an average of 6,729 pieces of litter per mile of roadway, with rural and urban roads having comparable litter content (Keep America Beautiful, 2009). An assessment of litter found in other "non-roadway" areas revealed between 46 and 584 pieces of litter per 1000 sq. ft. depending on the location type (Keep America Beautiful, 2009). While observations show a 61 % decrease in total roadway litter since 1969, the occurrence of plastic litter increased by 165 % (Keep America Beautiful, 2009). This is perhaps unsurprising, given that global plastic production has been increasing rapidly since the 1950s and has reached a production rate of over 380 million metric tons of plastic per year (Geyer et al., 2017). An estimated 50 % of plastic production is in the form of single-use materials, such as plastic bottles, bags, utensils, and packaging (United Nations Environment Programme, 2018). It is further estimated that 60% of the total 8.3 billion tons of plastic produced since the 1950's is either in landfills or has accumulated in the natural environment (United Nations Environment Programme, 2018).

Lake Tahoe and the Tahoe Basin is not exempt from this litter and plastic pandemic. Litter is known to accumulate along Lake Tahoe's beaches and shorelines despite many land-based litter cleanup efforts and litter awareness campaigns. These land-based Litter mitigation efforts include everything from self-organized, grassroots cleanups to statewide mandates intended to eliminate common litter items. For example, over 2,300 Tahoe Basin residents and visitors have joined The Tahoe Truckee Litter Group on Facebook where they contribute to the conversation and effort to remediate litter at a grassroots level (Facebook Groups, 2020). Litter cleanups organized by The League to Save Lake Tahoe have removed 35,000 lbs. of trash including 125,000 pieces of plastic in the last 6 years (AP News, 2019). At the local level, South Lake Tahoe instituted a ban on polystyrene (City of South Lake Tahoe, 2018). Single-use plastic grocery bags, a common litter item, were banned across the entire state of California (California Law, 2007). While these cleanup and mitigation efforts work to remove land-based litter, they also reveal a considerable and ongoing litter problem in the Tahoe Basin.

This littering problem does not end at the waterline. Litter deposited on land is subject to transport via wind and rivers into marine systems (Bergmann et al., 2015). These same litter transport pathways likely contribute to freshwater litter accumulation. Other lakebed litter sources include direct litter input from docks and boats. Submerged litter including plastic, rubber, cloth, and metal persists for decades or even centuries (Corcoran, 2015; U.S. National Park Service, 2018). In contrast to land-based litter, once the litter is submerged and settles on the lakebed it becomes very difficult to remove. The combined difficulty of removing submerged litter and its long degradation time can lead to substantial submerged litter accumulation on lakebeds and the sea floor.

Despite its clean and clear appearance, Lake Tahoe's nearshore lakebed is cluttered with decades of litter accumulation. Clean Up The Cayes (CUTC, a 501(c)3 non-profit) and their partners first discovered an abundance of lakebed litter in 2019 during two cleanup dives along Lake Tahoe's eastern shore, which removed over 900 lbs of litter along just 1.2 miles of nearshore lakebed. These findings launched the Clean Up The Lake (CUTL) program, which performs SCUBA-enabled cleanup dives to remove submerged litter from the Tahoe Basin's most venerated freshwater resources. Since its inception, CUTL has completed 21 cleanup dives in 2019 and 2020 and removed 8,781 lbs of lakebed litter in the Tahoe Basin. In 2020 the CUTL program completed 6 cleanup dives along Lake Tahoe's Nevada shoreline with support from a 2020 Lake Tahoe License Plate grant (LTLP 20-01) and Nevada Department of Environmental Protection grant (DEP S 21-005). These dives removed 1758 lbs. of litter along 7.1 miles of Nevada's nearshore lakebed. This does not include large, heavy-lift litter items that the team documented but did not remove, such as oil drums and plastic pipes on the lake bottom.

Widely regarded as a national treasure and deemed an EPA Priority Watershed, Lake Tahoe's oligotrophic waters support a robust tourism economy and provides a plethora of services to the Tahoe Basin and its residents including habitat for aquatic and terrestrial wildlife, clean drinking water, and recreational opportunities. The extraordinary efforts put forth by numerous national, state, and local entities, including government, private, and non-profit organizations, have made leaps and bounds towards improving Lake Tahoe's water quality and ecosystem health, as well as preserving the scenic beauty and recreational value of the Tahoe Basin. However, more work is needed to remove litter that has accumulated beneath Lake Tahoe's clear blue waters. The Clean Up The Lake program is leading this effort by coordinating and conducting nearshore, lakebed litter clean-up efforts along Tahoe's 72- miles of shoreline. This cleanup effort is anticipated to remove thousands of pounds of lakebed litter, ultimately making strides towards mitigating the impacts of litter degradation while also restoring Tahoe's lakebed aesthetic.

Here we present the results of 7.1 miles of lakebed litter cleanups completed along Lake Tahoe's Nevada shoreline in 2020.

SCUBA-enabled Cleanup Methods

SCUBA-enabled litter removal

Submerged litter studies and removal efforts have used dredging, remote operated vehicles (ROVs), submersibles, sonar, snorkeling, and SCUBA-diving (Corcoran, 2015; Maes et al., 2018). Sonar, ROVs, and submersibles are able to collect data on submerged litter but have limited ability to remove it. While dredging may efficiently remove litter along sandy shorelines it is likely ineffective in Tahoe's rocky terrain. Dredging also disrupts lakebed habitat and entrains substantial amounts of sediment in the water column (Erftemeijer and Robin Lewis, 2006; Olsgard et al., 2008; Ward-Campbell and Valere, 2018). These side effects are not in keeping with Tahoe Regional Planning Authority (TRPA) Environmental Improvement Program (EIP) objectives established to preserve and restore Lake Tahoe to its natural state (TRPA EPI, 2020; TRPA Threshold, 2020). The mechanical disruption from an aggressive dredging operation may also break apart and disperse disintegrating litter items such as crumbling tires collected during 2020 cleanup dives (Fig. 1). Snorkeling, while requiring less experience and equipment, limits litter cleanups to shallower waters (e.g. < 10 feet deep) and only allows for quick dives to retrieve lakebed litter. Snorkeling would substantially limit the scope of work and likely remove less litter compared to SCUBA-enabled litter cleanup efforts.

SCUBA-enabled litter cleanups are an effective approach for removing lakebed litter in nearshore environments (e.g. Dive Against Debris, 2019). Divers can safely swim along the lakebed and scour rocky outcrops at depths of 25 feet at high elevation (Fig. 2). The precision litter collection that divers provide can extract items from crevices in rocks where submerged litter often accumulates and reduces litter breakdown during removal. Divers also have little impact on the lakebed habitat compared to dredging. Based on these attributes SCUBA-enabled lakebed litter removal provides the most effective approach for removing litter from variable underwater terrain down to 25 feet below the surface without causing damage to Lake Tahoe's lakebed habitat.

Cleanup dive implementation and protocols

Cleanup dives begin at daybreak to take advantage of calm water. Each cleanup dive-day enlists 4 to 6 divers and cleans between 1 – 1.5 miles of nearshore lakebed. Dive and swim-patterns are selected to safely maximize the amount of terrain covered. Each dive team includes at least 3 surface support personnel, including a boat captain and jet ski captain. Surface personnel facilitate litter retrieval, diver safety, and data collection. The dive team reviews dive, communication, and safety protocols before each cleanup. During each cleanup dive, divers and surface support work together using traditional and customized hand signals to convey and record field data. All divers work in pairs and collect litter in dive bags (Fig. 2). Surface support personnel pull litter-filled dive bags to the surface with rope.

This method reduces mobilization time, and improves diver safety, and the team's ability to get off the water in the event of rapidly changing weather. CUTL deployed this method during August 2020 and was able to complete morning cleanup dives, prior to the onset of afternoon storms and wind. It also reduces gathering size and prevents crowding on the boat during the ongoing COVID-19 pandemic while still providing sufficient manpower to remove litter from the nearshore lakebed.

Figure 1 *Disintegrating tires removed from Donner Lake by the CUTL program in 2020.*

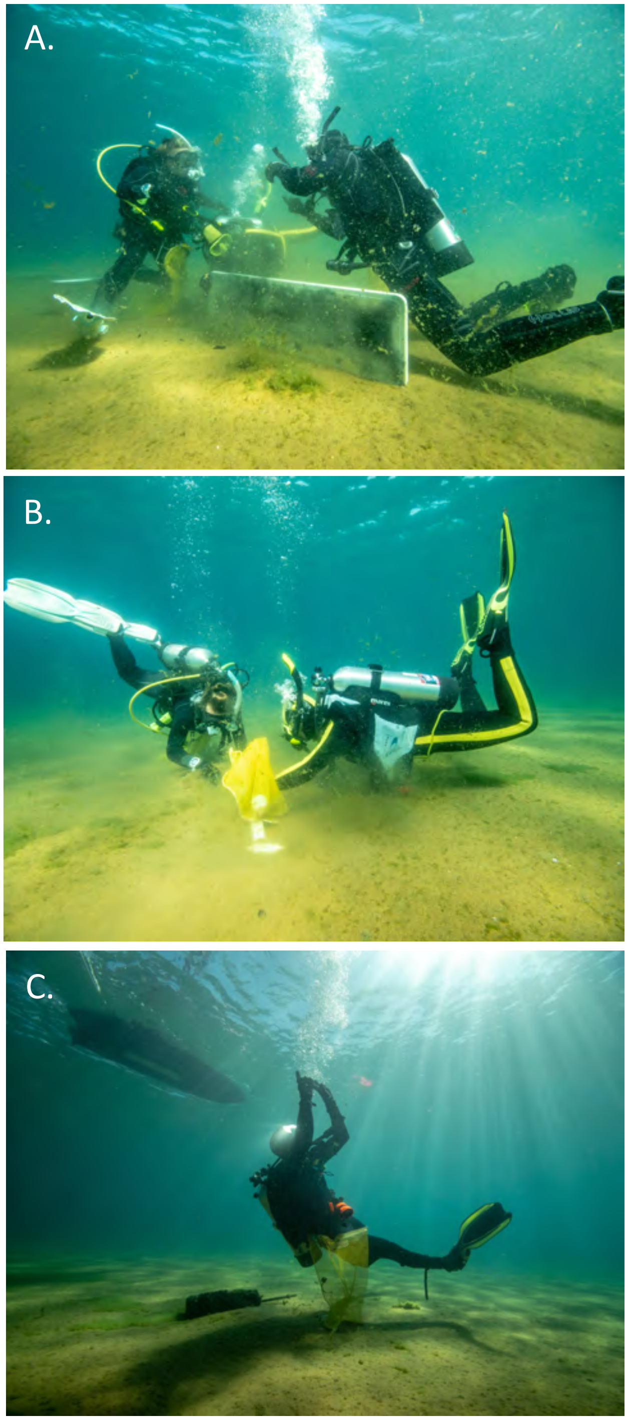

Figure 2 *Divers removing litter from Lake Tahoe during the 6-mile LTLP 20-01 project in 2020. A. Colin West, Executive Director, Meghan Burk, Chairman of the Board, and Luba Guvernator, Professional Dive Master/Volunteer remove a boat piece from the lakebed. B. Meghan Burk and Luba Guvernator collecting lakebed litter in yellow dive bags. C. Colin West, signaling to the surface support team with underwater hand signals to report a heavy-lift item. Sadye Easler, Program Manager and free diver, is outside the frame communicating to the jet ski at the top left of the photo. The jet ski captain has a mobile device and records the data and GPS location of the heavy lift item in the WildNote Non-collection form.*

Safety and COVID-19 protocols

SCUBA diving above 1,000 feet elevation is considered high altitude diving and requires additional precautions. At 6,224', Lake Tahoe falls well within this definition. CUTL developed a high-elevation safety protocol for cleanup dives in the Tahoe Basin. Protocols include limiting dives to 25 feet depth and 2 to 3 tank dives per day. Considerations for low water temperatures and high air temperatures are also taken into account. The cleanup dive schedule (maximum 3 days per week) affords divers a 24 h window between dives to ensure that divers' blood nitrogen level and body temperature return to normal. These safety protocols were established in consultation with Sierra Dive Center.

All divers are vetted prior to participating in cleanup dives. A team brief occurs before each dive to review the dive plan and safety protocols. Surface personnel carry first-aid and oxygen kits in case of emergencies and key personnel have first aid and CPR training. Additional safety measures include professional and rescue diver participation and strict adherence to the buddy system. Divers follow the NV requirement to swim within 100' of dive flags at all times. Surface support personnel communicate with boaters in the vicinity to ensure diver safety. The Coastguard is notified of cleanup dives and kept in close communication.

The 2020 Lake Tahoe Cleanup Dive Crew

Steve Blaney – Surface Support
Meghan Burk – Diver
Michelle Burlitch – Surface Support, Free Diver
Paul Colby – Diver
Kelly Crocker – Surface Support, Free Diver
Sadye Easler – Surface Support, Free Diver
Hayden Farris – Surface Support, Free Diver
Karl Fenderlander – Diver
Ludovic Fekete – Surface Support, Free Diver
Brad Flora – Surface Support, Boat Driver, Data
Jared Getzoff – Diver
Daniel Goldstein – Surface Support, Boat Driver
Luba Guvernator – Diver
Sara Hadden – Surface Support, Free Diver
Normal Halverson – Diver
Cameron Hornish – Diver
Randy Malm – Diver
Genna Masters – Surface Support, Boat Driver
Lynn Mattoon – Diver, Surface Support
Hailey Murphy – Surface Support
Terrence Reardon – Diver
Sarah Rosenthal – Surface Support
Ben Saenz – Surface Support, Boat Driver, Data
Jason Smith – Diver
Amanda Shoemaker – Diver, Surface Support
Liz Stinson – Surface Support
Keith Thomas – Surface Support, Boat Driver
Hannah Urrutia – Data, Surface Support
Tiara Wassner – Surface Support
Colin West – Lead Diver
Mike Witherspoon – Diver

With the onset of the COVID-19 pandemic, CUTL implemented new safety protocols for all cleanup dive participants. All divers complete a pre-dive health screen regarding COVID-like symptoms and diver health. Masks are worn during all surface activities, including litter categorization efforts. The CUTL program also took steps to reduce the cleanup dive team size to limit the size of gatherings and reduce crowding on dive boats. There were no cleanup dive or litter sorting participants that contracted COVID-19.

Field data collection

Comprehensive data collection is a tenet of the CUTL program and cleanup dives. Field data collection includes the following forms and content:

Dive Day Form – A data collection form that captures information on cleanup dive participants, conditions, and location. Entry fields include: Project Name; Form ID; Survey Date; User Name; Dive Number (mile.segment.team); Data Collector; [SCUBA] Divers; Free Divers; Boat Drivers; Jet Ski Drivers; Surface Support; Dive Day Start and End Location (Latitude Longitude, Accuracy); Start and End Time; Air and Water Temperature (F); AM and PM Summary; Weight on Dives #1 - 3; Weight of Trash Removed Today

Dive Segment Form – A form that captures the start and end point for each air tank dive completed in a given dive day. Litter is removed, labeled, and sorted per each tank dive which establishes a 0.3 to 0.5-mile spatial granularity for litter data. Entry fields include: Project Name; Survey ID; Survey Date; User; Dive Number; Start and End Location (Latitude, Longitude, Accuracy).

Non-Collection Item Form – Non-collection item forms record heavy-lift litter, litter "hotspots," and other points of interest that divers communicate to surface support personnel through hand signaling. Data include Dive Number, location and item type. In 2020, 7.1 miles of LTLP cleanup dives yielded 161 non-collection items including oil drums, PVC pipes, and a sunken dingy.

All three forms are built in WildNote, a data collection application that operates on desktop, as well as iOS and Android mobile devices. All data were collected in the WildNote app which standardizes data collection and digitization.

Litter data collection

CUTL utilizes a comprehensive UNEP/IOC marine litter characterization table that groups litter into 9 material categories, and 77 sub-categories according to litter use/source (Cheshire et. al, 2009; Fig. 7, Table A1, Table A2). This categorization system is one of the most thorough methods for sorting litter, establishes a high-quality benchmark for freshwater litter data collection, and provides robust data on common litter sources. CUTC will continue to use this categorization method for all cleanup efforts planned for 2021 and beyond in order to standardize our data collection approach and generate insights on litter sources and sinks. Some updates to the table were implemented based on litter content from the 2020 cleanup dives. For example, masks are a relatively new litter type that is not included in the UNEP/IOC categorization system. Mask litter was added to category "CL06: Cloth – Other cloth." Categorization table updates also promote litter sorting consistency.

CUTL developed a litter sorting method suitable for engaging volunteers. This method includes a series of customized tarps with 77 sorting grids corresponding to each the 77 UNEP/IOC litter categories. Litter collected during each cleanup dive segment is sorted onto the tarps and each category is weighed and photographed. Litter weight is recorded in a WildNote form along with litter sorting meta-data (e.g. date, time, lead personnel, volunteers). This work included testing and refining the litter sorting method and categorization tables.

2020 Lake Tahoe Cleanup Locations

Approximately 28 miles of Lake Tahoe's shoreline are located in Nevada, from Crystal Bay to Stateline. While it is possible that the northern and southern circular currents, called gyres, within Lake Tahoe (Steissberg et al., 2005) may redistribute and influence underwater litter accumulation zones, we anticipate more populated regions of the shoreline to correlate with increased, nearshore lakebed litter. This hypothesis is consistent with findings in marine systems where seafloor litter accumulation was positively correlated with shoreline population (Jambeck et al., 2015; Maes et al., 2018). A 2019 pilot clean-up dive coordinated by CUTL also provided preliminary evidence for submerged litter accumulation along popular shorelines in Lake Tahoe. This pilot cleanup dive spanned ~ 0.7 miles from Whale Beach to just North of Secret Cove along a popular public beach and recovered 311 lbs. of submerged litter (data not shown).

CUTL therefore prioritized the majority of the 2020 cleanups in the most populated and popular stretches along Lake Tahoe's Nevada state shoreline. The removal of nearshore litter along these sections of Nevada's shoreline provides insight into submerged litter accumulation patterns along Lake Tahoe's Nevada shoreline and mitigates the impacts of underwater litter degradation on a regional and perhaps lake-wide scale.

In 2020 the CUTL Program completed 7.1 miles of nearshore lakebed litter removal along Lake Tahoe's Nevada shoreline. Specific sites selected for litter removal include shoreline adjacent to:

- *(i)* Elk Point/ Nevada Beach Campground (1.30 miles, dive day 1, Fig. 3, 4)
- *(ii)* Zephyr Cove (1.48 miles, dive day 2, Fig. 3, 4)
- *(iii)* South Sand Harbor (1.04 mile, dive day 3, Fig. 3, 5)
- *(iv)* East Incline/NV State Park (1.35 miles, dive day 4, Fig. 3, 6)
- *(v)* Hidden Beach (0.59 miles, dive day 5, Fig. 3, 6)
- *(vi)* W Incline/ Incline Beach (1.34 miles, dive day 6, Fig. 3, 6)

Each of these sites were selected based on the relatively high local population (e.g. Incline), popularity with beachgoers, boaters, and vacationers (e.g. NV Beach, Incline beach, Hidden Beach, Sand Harbor, and Zephyr Cove), or a predominance of rocky substrate (e.g. S Sand Harbor and Hidden Beach). Clean up locations also span shoreline in both southern and northern sections of the lake in order to evaluate N/S litter accumulation trends along the entire NV shoreline.

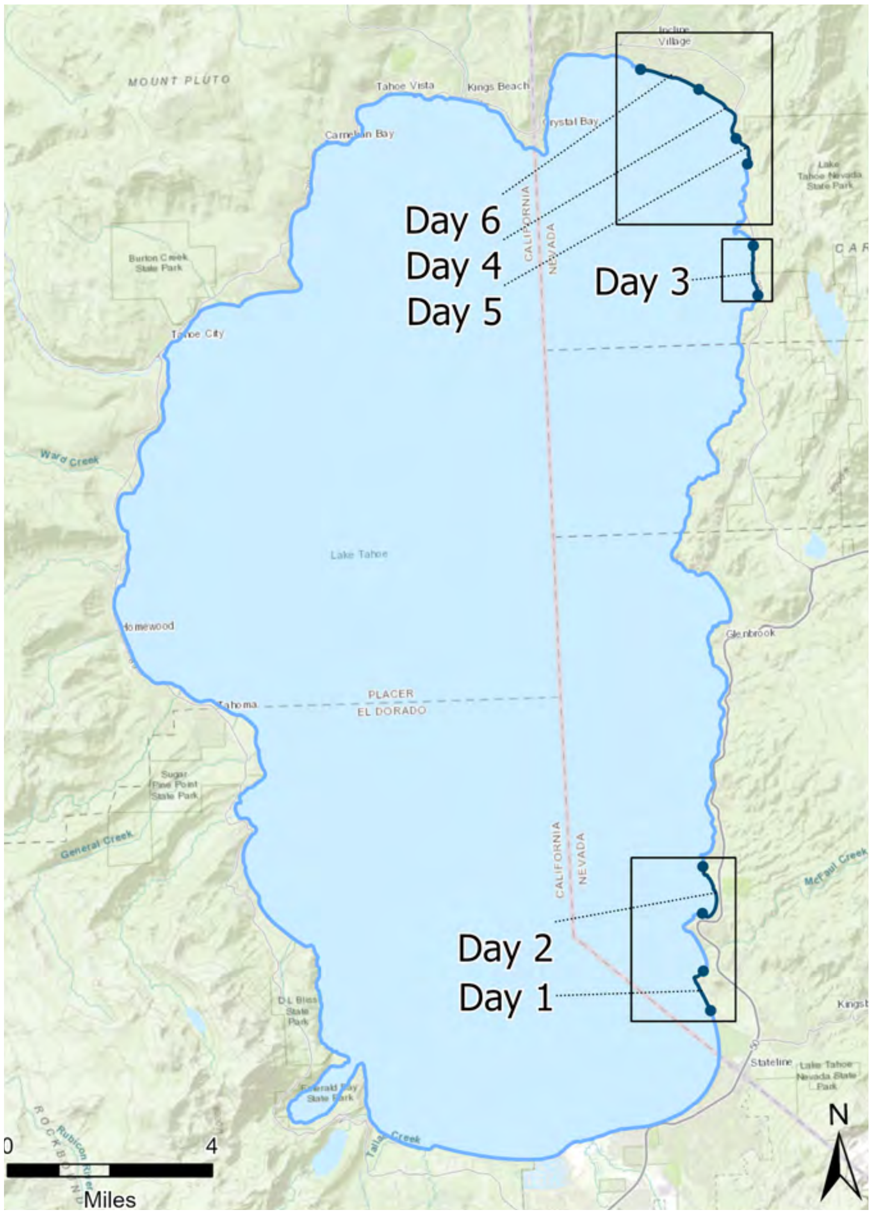

Figure 3 *Cleanup dive tank segments for dive day 1, along Elk Point/ NV Beach, and dive day 2, along Zephyr Cove. Litter data correspond to each dive tank segment and dive day.*

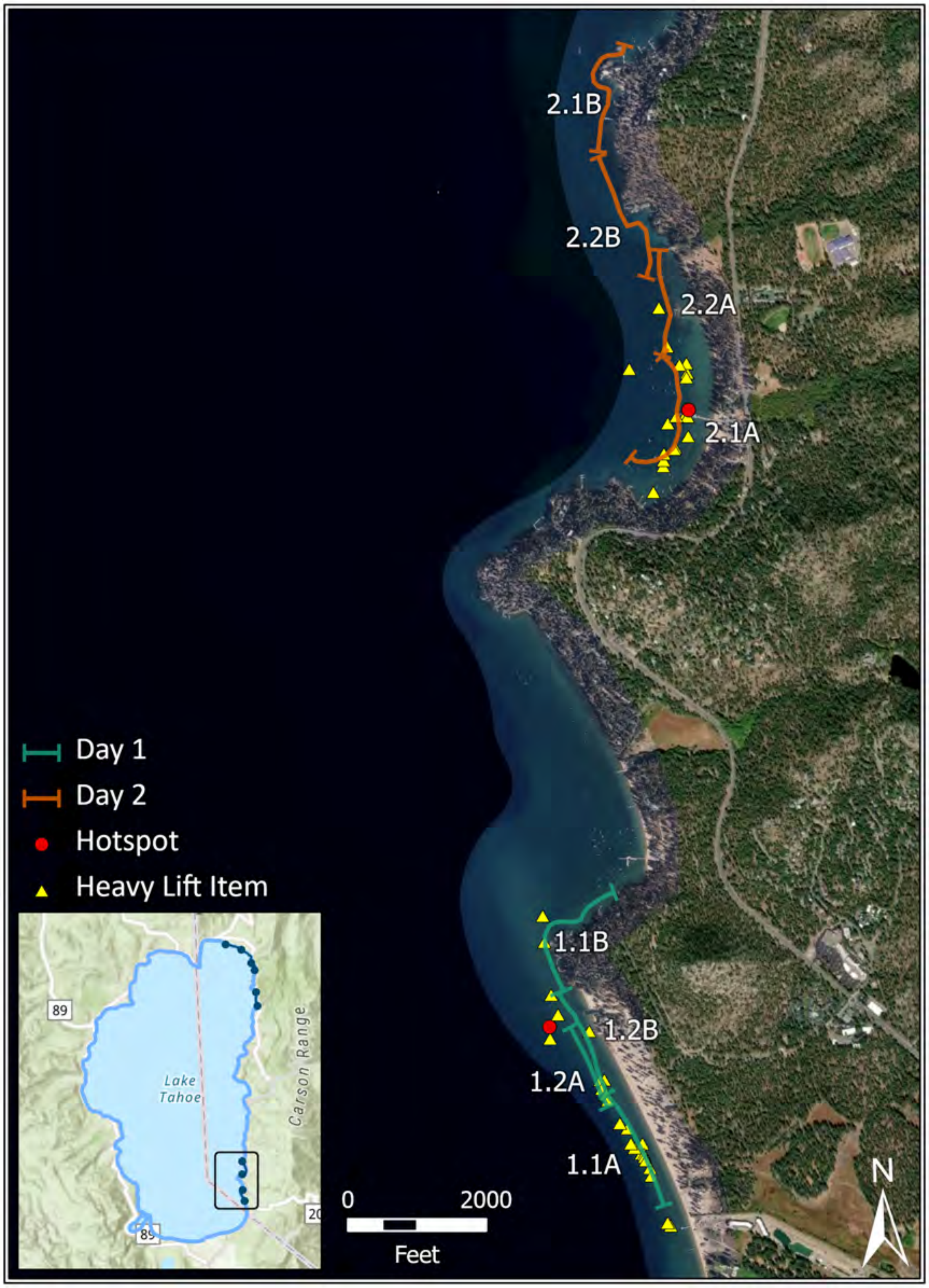

Figure 4 Cleanup dive tank segments for dive day 1, along Elk Point/ NV Beach, and dive day 2, along Zephyr Cove. Litter data correspond to each dive tank segment and dive day.

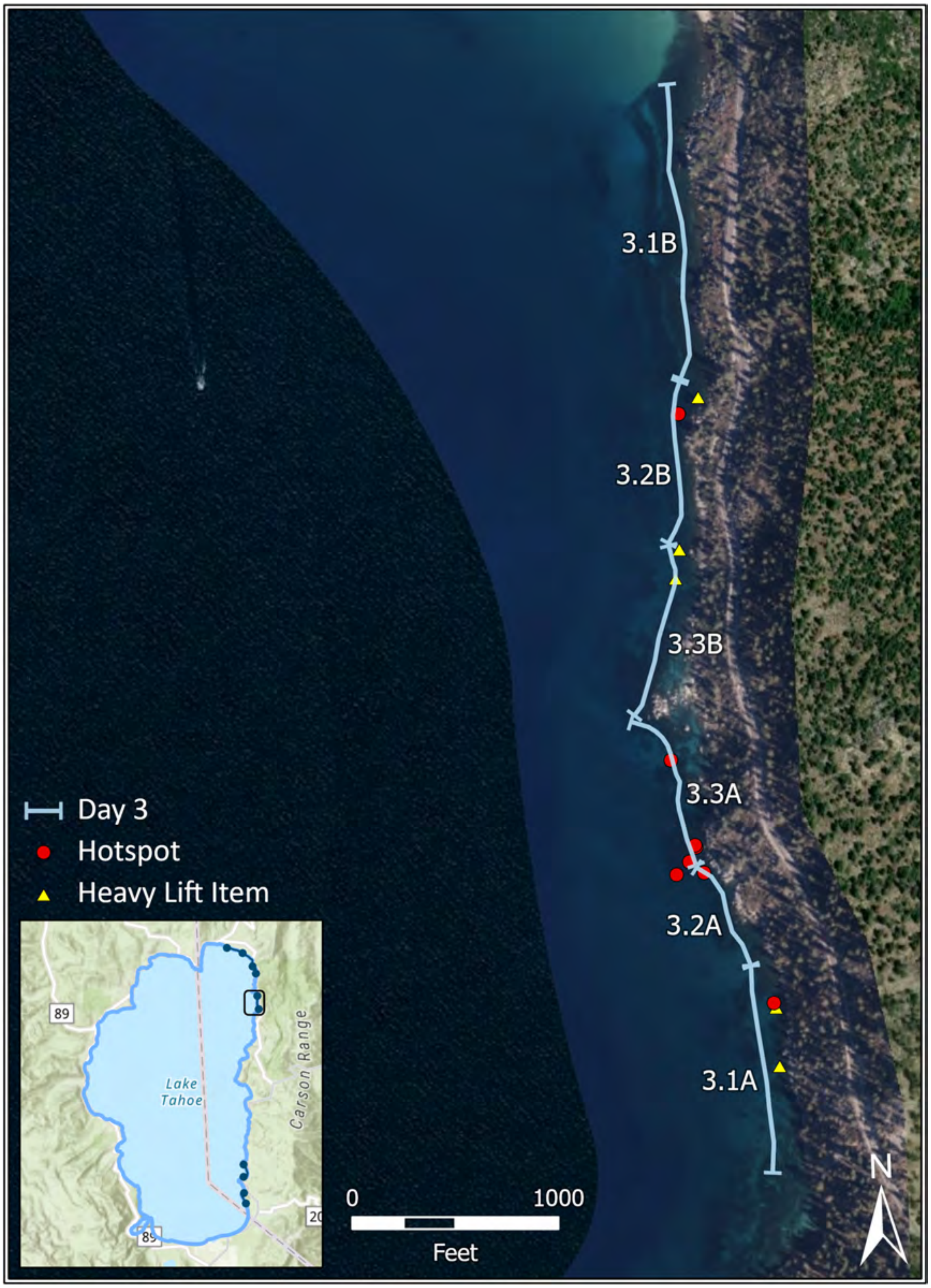

Figure 5 Cleanup dive day 3, along S Sand Harbor, was the rockiest stretch of shoreline cleaned in 2020.

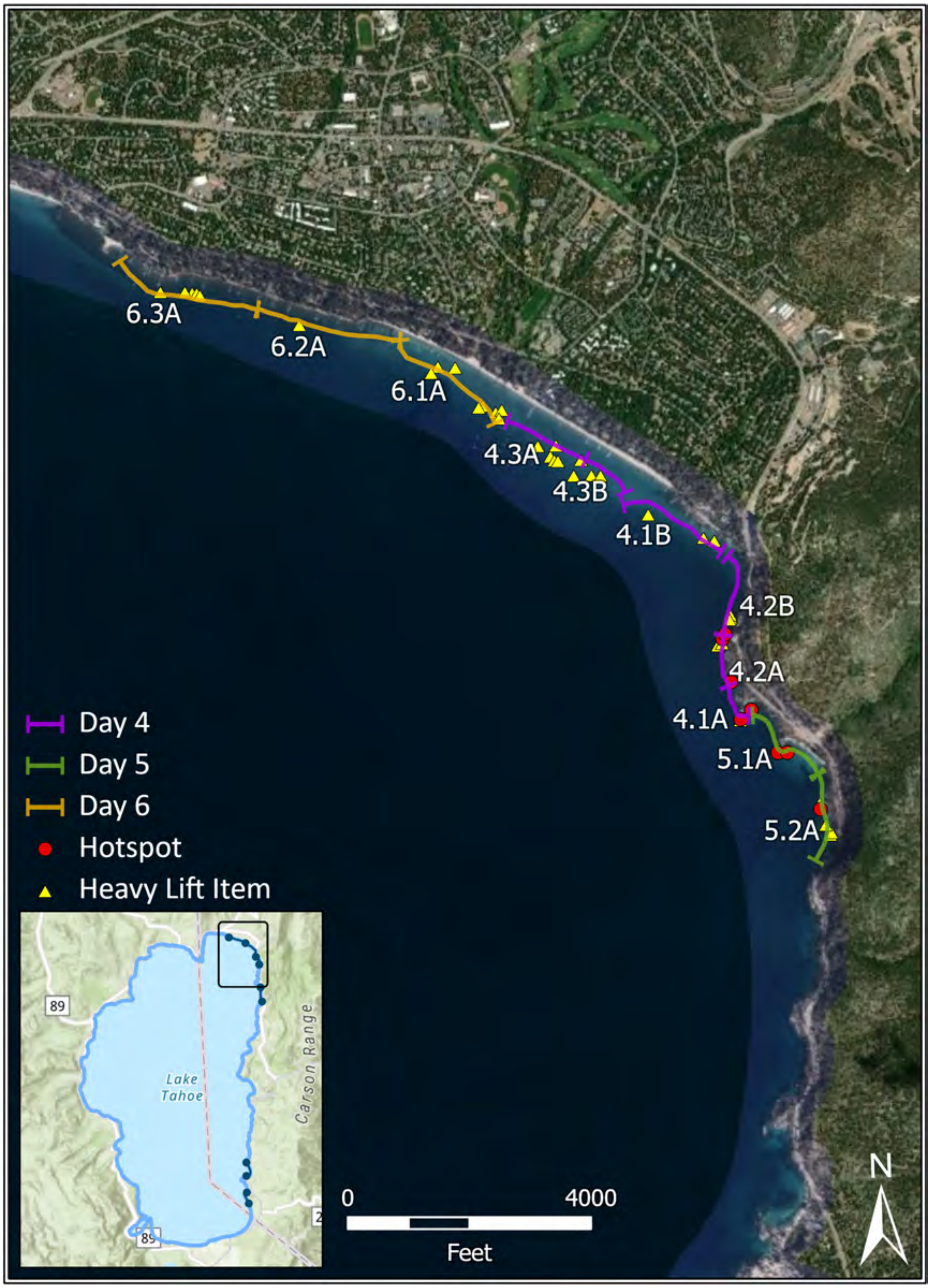

Figure 6 *Cleanup dive tank segments: dive day 6, W Incline/ Incline Beach; dive day 4, E Incline/ NV State Park; dive day 5, Hidden Beach. Litter data correspond to each dive tank segment and dive day.*

Cleanup dives totaling 2.8 miles in the southern reaches of the lake were located along Elk Point/NV Beach and Zephyr Cove (Fig. 3, 4). Nevada beach includes campsites as well as daytime access to a popular section of sandy beach. Boat rentals and public beaches at Zephyr Cove Marina bring visitors to this community of 565 residents. Neighboring Stateline, while only having a population of 842, is the site of numerous hotels, casinos, and event centers which draw visitors year-round.

Along Nevada's northeastern shore, CUTL completed cleanup dives totaling nearly 4.3 miles. These dives skirted the Incline shoreline and Nevada State Park, which includes Hidden Beach and southern Sand Harbor shores (Fig. 3, 5, 6). Incline is home to 8,777 year-round residents, making it the largest city along Lake Tahoe's Nevada shoreline. Incline village also hosts many summer visitors who frequent Incline beach as well as private beaches along the northeastern shorelines of Crystal Bay. Hidden Beach is a popular, public walk-in or boat-in access beach that draws may locals and visitors in the summer months.

Pilot cleanup dives in 2019 recovered substantial amounts of litter within crevices in boulder piles. This provided qualitative evidence suggesting that litter accumulation was more prevalent along rocky shorelines and submerged rock outcrops compared to regions characterized by sandy lakebed. It is possible that rocky sections of Tahoe's shoreline could serve as litter sinks, effectively straining out and accumulating litter that is transported from land or from other parts of the lake via wind and water currents. CUTL sought to further test this hypothesis during 2020 by completing a 1-mile cleanup dive along a stretch of rocky shoreline just south of Sand Harbor. Sand Harbor, located in Nevada State Park, boasts two boat ramps, long stretches of sandy beach and summer programs. South of this popular destination is a rocky shoreline. Results of this dive (dive day 3) compared to other 2020 cleanup dives along sandy lakebed provide preliminary insight on the role of lakebed substrate on litter accumulation patterns.

Litter Removed From Lake Tahoe

Total Litter Removed

CUTL removed 1,758 lbs. of litter over 7.1 miles of 2020 Lake Tahoe cleanup dives (Table 1). This equates to an average of 251 ± 84 lbs. of litter per mile cleaned based on dive day totals (Table 1).

Metal litter items were the most prevalent material recovered by weight during the dives, totaling 842 pounds of material (Fig. 8, Table A1). Metal items retrieved during the 2020 dives primarily fell within three of ten metal litter sub-categories (Fig. 7): Other (ME-10, 580 lbs.); Aluminum drink cans (ME-03, 118 lbs.); and fragments (ME-08, 88 lbs., Table A2). The most common metal litter items classified under "other" were disconnected metal pipes, possibly relics of local water intake systems no longer in use. The 1120 Aluminum cans the team collected suggests a direct litter input pathway from boaters during recreational activities. Two anchors also contributed substantially to the total metal litter removed. Fishing items such as traps, hooks, and line sinkers were also common litter items and are consistent with the popularity of recreational activities in the locations cleaned. The prevalence of aluminum cans may also indicate land-to-water input and transport process associated with shoreline recreation.

Notably, plastic was the second most common submerged litter material by weight (Fig. 8, Table 3). This is surprising insofar as plastic density, or weight per volume, is substantially lower compared to metal. This suggests that the volume of plastic litter removed exceeds that of other heavier litter material categories such as glass and ceramic removed over the 7.1 mile cleanup. Plastic litter was dominated by two of 24 sub-categories: Fiberglass Fragments (PL-22, 96 lbs.); and Other (PL-24, 145 lbs.). Fiber glass is a common construction material for motorized boats as well as kayaks and other recreational water craft. Watercraft degradation and breakage is the most likely input of fiberglass material and was often found in large pieces suggesting individual breakage events (e.g. a swim deck breaks off a boat and sinks) versus frequent input pathways or land-to-water transport processes. "Other" plastic items included fragments of other plastic materials, possibly from boats and water craft breakage events. Smaller plastic items included single use plastics (e.g. beverage and food containers) and recreational equipment (e.g. goggles, flippers, and golf balls, Fig. 12 -17). While not a major source of litter by weight these items implicate either direct or indirect, land-to-water litter transport pathways associated with recreational activities.

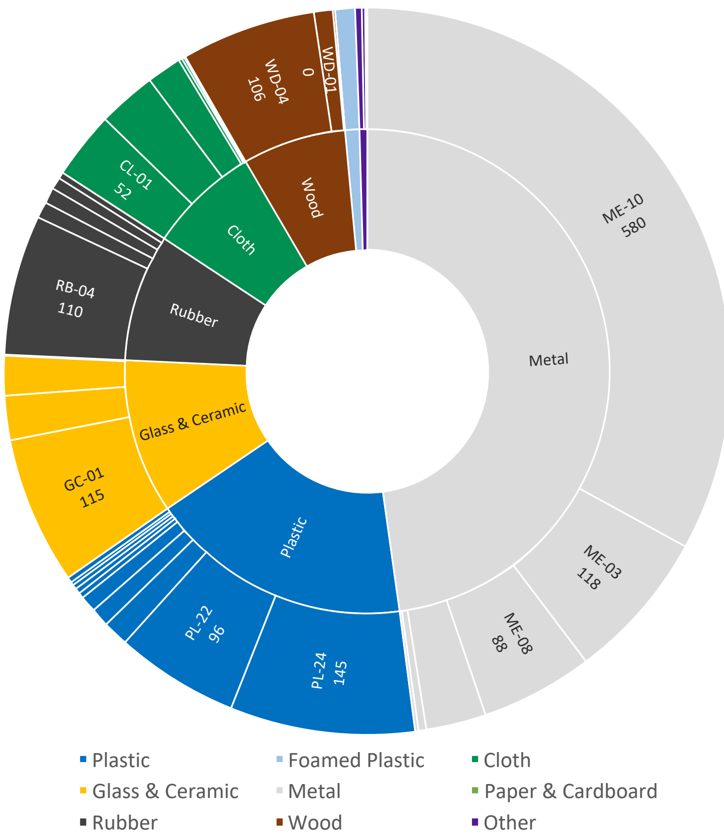

Figure 7 of litter removed by weight per material (inner ring) and material sorting category (outer ring). Major categories include the category ID and total weight removed over the 6-mile cleanup (data labels).

From a pollutant stand point, it is important to note that items in the rubber and cloth material categories are often comprised of plastic. Rubber tires are partially or entirely made of synthetic rubbers, which are polymers similar to plastics. Synthetic and synthetic blend clothing (e.g. polyester, elastics) and ropes are composed of plastic fibers.

Other materials recovered during the 2020 cleanup dives included: Glass and Ceramics, dominated by construction materials (GC-01, 115 lbs.); Rubber, largely comprised of tires (RB-04, 110 lbs.), Cloth, largely clothing and ropes (130 lbs total), and wood namely construction materials and processed timber (121 lbs. total, Fig. 8, Table A1). Very few foamed plastic and paper products were recovered (Fig. 8, Table 3). This is perhaps unsurprising in regards to paper products, which are more likely to disintegrate rapidly compared to the decade to century long lifespan of plastics. Foamed plastics on the other hand, such as Styrofoam, have a slow degradation rate spanning decades of centuries. The general lack of foamed plastic recovered during the cleanup dives may suggest that this material does not sink or accumulate on the lakebed. It may also indicate that anti-Styrofoam campaigns have successfully reduced the use of single use Styrofoam thereby decreasing its contribution to litter accumulation.

Regional Litter Accumulation Trends

Submerged litter were collected and sorted according to each dive tank segment which provide data at a sub-mile (~ 0.3 mile) granularity. We present data at both the dive tank segment (~ 0.3 mile) and cumulative dive-day (0.6 to 1.5 mile) granularities. Data are discussed in pounds (lbs.) per mile (lbs./mi.), heavy-lift litter items per mile, or diver-identified hot spots per mile. This allows for direct comparison between operationally defined regional (~ 1 mi.), localized (~ 0.3 mi.), and "point" (< 50 yds.) litter accumulation trends respectively.

***Litter Hot Spots** – Litter "hot spots" are defined as those areas with above average litter accumulation measured over the 7 miles cleaned. Litter hot-spots are evaluated at three granularities, including dive day (~ 1 mile), dive tank segment (~ 0.3 mile), and individual diver observations. Diver identified hot-spots are collected during each dive and reflect the most granular litter accumulation metric, estimated at 50 yards or less from each recorded diver hot-spot point. These three hot spot granularities provide insight on what is operationally defined as regional (~ 1 mile), local (~ 0.3 mile) and point (< 50 yards) litter hot-spots.*

On a regional (1 ± 0.4 mile) scale litter concentrations ranged from as high as 409 lbs./mi along S Sand Harbor down to 180 lbs./mi along Elk Point/ NV Beach and 196 lbs./mi. Zephyr Cove (Table 1). Notably, the low end of litter concentrations encountered is still a substantial amount of submerged litter. Regional as well as local (~ 0.3 mi.) hot spots at S Sand Harbor, E Incline/ NV State Park and W Incline/ Incline Beach are readily apparent relative to other dive day regions (Table 2, Fig. 6). Zephyr Cove and Elk Point/ Nevada Beach had the least litter per mile, but still totaled nearly 200 lbs./mi of litter accumulation.

Table 1 *Total litter removed by dive day and sorted according to litter per mile Z-score, or the number of standard deviations above and below the lbs/mile average. That is a Z-score of 1 is 84.2 lbs./mile above the average 251.1 lbs./mile.*

Location	Dive Day	Total (lbs.)	Distance (mi)	lbs per mile	Z-score (lbs./mi.)
S Sand Harbor	Day 3	427.6	1.04	409.4	1.9
W Incline/ Incline Beach	Day 6	372.4	1.34	276.9	0.3
E Incline/ NV State Park	Day 4	305.8	1.35	226.0	-0.3
Hidden Beach	Day 5	128.3	0.59	217.7	-0.4
Zephyr Cove	Day 2	290.0	1.48	196.5	-0.6
Elk Point/ NV Beach	Day 1	234.2	1.30	180.3	-0.8
	Total	**1758.3**	**7.1**		
	Average	**293.1**	**1.2**	**251.1**	
	Standard Deviation	**105.1**	**0.3**	**84.2**	

Table 2 *Total litter removed by dive tank segment and sorted according to litter per mile Z-score, or the number of standard deviations above and below the lbs/mile average. That is a Z-score of 1 is 226.0 lbs./mile above the average 275.0 lbs./mile.*

Location	Dive Number	Total (lbs.)	Distance (mi.)	lbs. per mile	Z-score (lbs./mi.)
S Sand Harbor	3.2B	164.3	0.15	1079.0	3.6
E Incline/ NV State Park	4.2B	159.3	0.27	589.8	1.4
E Incline/ NV State Park	4.2A	64.4	0.16	402.7	0.6
S Sand Harbor	3.2A	42.2	0.11	395.0	0.5
S Sand Harbor	3.3A	58.9	0.16	377.5	0.5
W Incline/ Incline Beach	6.2A	167.0	0.46	366.8	0.4
Elk Point/ NV Beach	1.2A	83.0	0.24	344.7	0.3
W Incline/ Incline Beach	6.3A	159.9	0.48	336.0	0.3
Elk Point/ NV Beach	1.1A	108.9	0.34	316.9	0.2
Hidden Beach	5.2A	88.4	0.28	312.3	0.2
E Incline/ NV State Park	4.1A	40.8	0.13	309.6	0.2
S Sand Harbor	3.1B	82.8	0.27	302.0	0.1
S Sand Harbor	3.1A	57.7	0.19	300.8	0.1
Zephyr Cove	2.2B	93.5	0.40	234.1	-0.2
Zephyr Cove	2.1A+B	168.3	0.78	215.7	-0.3
S Sand Harbor	3.3B	21.8	0.16	133.3	-0.6
Hidden Beach	5.1A	39.9	0.31	130.3	-0.6
W Incline/ Incline Beach	6.1A	45.4	0.41	109.8	-0.7
Zephyr Cove	2.2A	28.2	0.30	95.2	-0.8
E Incline/ NV State Park	4.1B	33.2	0.36	93.0	-0.8
Elk Point/ NV Beach	1.2B	25.7	0.31	82.8	-0.9
Elk Point/ NV Beach	1.1B	16.6	0.40	41.0	-1.0
E Incline/ NV State Park	4.3A	7.9	0.27	28.9	-1.1
E Incline/ NV State Park	4.3B	0.3	0.16	2.0	-1.2
	Total	**1758.3**	**7.1**	**-**	
	Average per tank	**73.3**	**0.3**	**275.0**	
	Standard Deviation	**54.7**	**0.1**	**226.0**	

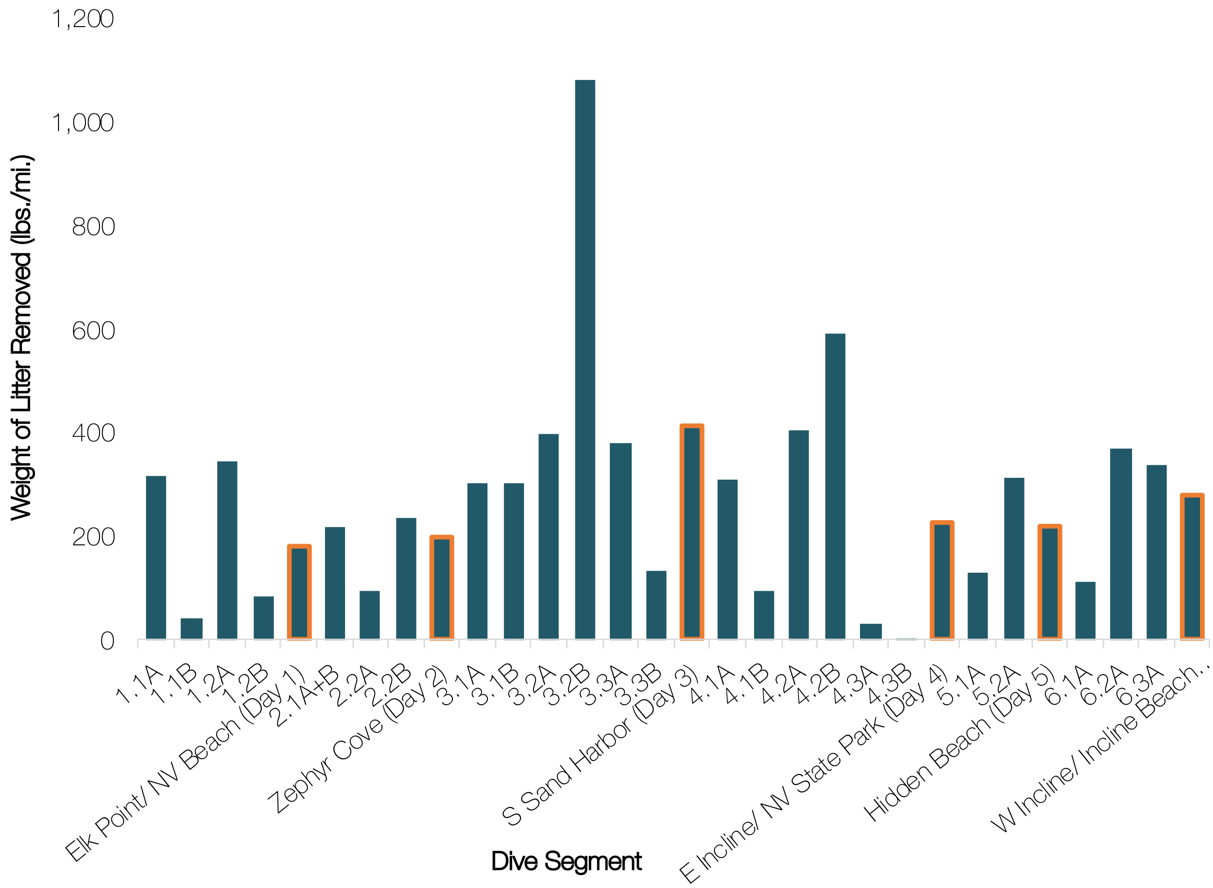

Figure 8 Litter weight per mile (data labels) removed by dive tank segment (yellow) and dive day (yellow with blue outline) for each of the six dive days. Regional and local litter accumulation hot spots are co-located with popular public and community beaches or rocky shorelines.

South Sand Harbor

S Sand Harbor was the most polluted segment cleaned in 2020, with litter accumulations 1.9 standard deviations above the sampled average at the regional granularity (Table 1, Fig. 6). The total distance cleaned (1.04 mi) was completed in six dive segments ranging from 0.27 to 0.11 miles (Table 2). Three of the total six cleanup dive segments ranked in the top 5 most polluted dive segments based on weight per mile removed (Table 2, Fig. 6).

Litter at S Sand Harbor was dominated by metal materials (Fig. 10). Metal litter was predominantly characterized by Aluminum (Al) drink cans (95 lbs.) and "Other" items (83 lbs.), especially boat anchors and components. Notably, S Sand Harbor had the highest concentration of Al drink cans relative to all locations cleaned in 2020, totaling 876 cans (Fig. 11 and 12).

Plastic was the second most common litter material removed along S Sand Harbor. Plastic materials were dominated by fiberglass fragments (PL-22, 71 lbs total, Fig. 10), which were concentrated in local dive segment 3.2B (43 lbs.) and 3.1B (28 lbs., Fig. 7). The second and third most common plastic sub-categories were "other" (11.7 lbs total) and toys, or recreational equipment (11.2 lbs. total). The S Sand Harbor region also had the highest amount of clothing accumulation (CL-01, 23 lbs.), two times higher than Hidden Beach, the second highest clothing accumulation region (Fig. 10, Table 10).

Interestingly, S Sand Harbor was also one of the rockiest regions cleaned in 2020. The dominant metal and plastic material sub-categories are consistent with boat damage/entrainment events along the rocky shoreline leading to fiberglass fragment, anchor and other boat component accumulation. The high concentration of Al drink cans and clothing is consistent with the hypothesis that litter is ensnared in rocky substrates, rendering them litter sinks or accumulation zones.

The accumulation of Al drink cans, recreational equipment, and clothing is also likely correlated to the location's proximity to Sand Harbor beach. Located near the popular Sand Harbor public beach, is it possible that nearby land-based as well as direct litter input migrates to and becomes ensnared in the submerged rocky substrate where it can accumulate over time. It is also possible that litter accumulation along this S Sand Harbor shoreline originates from other regions of the lake and is transported to the west shore via wind and water currents.

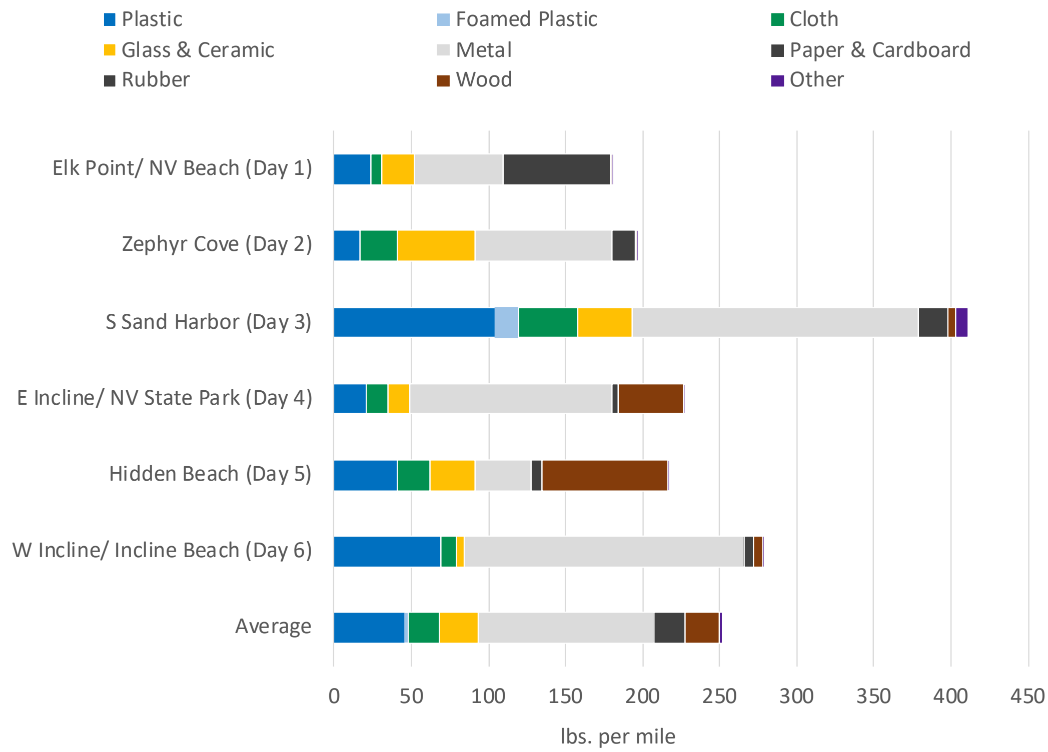

Figure 9 *Litter removed (lbs. per mi.) by dive day. Material proportions and bar totals plots are directly comparable. The two most litter polluted shoreline regions, Sand Harbor and Incline, are synonymous with the rockiest or most visited and populated regions cleaned, respectively.*

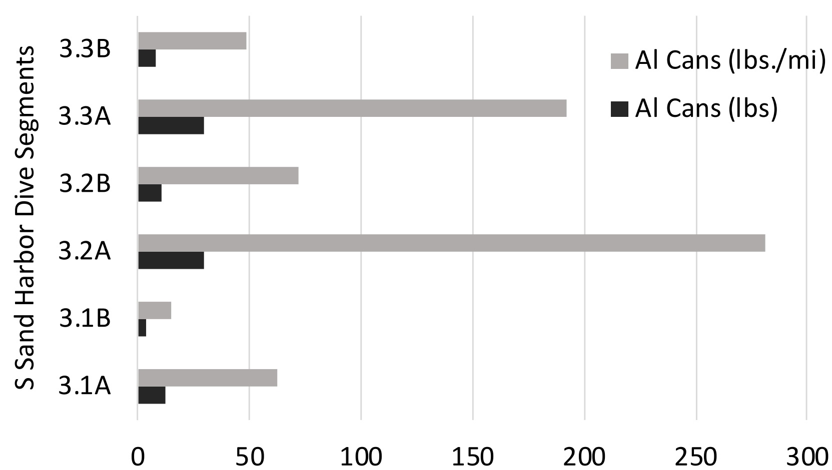

Figure 10 *Aluminum drink cans by weight and weight per mile removed along S Sand Harbor.*

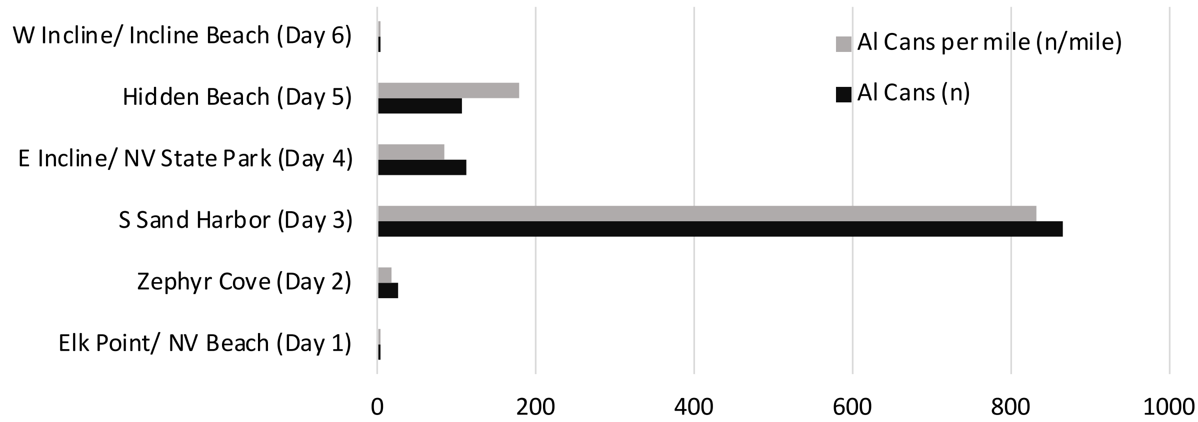

Figure 11 *Aluminum drink cans are a sure sign of littering during recreational activities. The highest concentration of drink cans was found at S Sand Harbor, a rocky shoreline just south of a popular public beach and the most overall polluted shoreline region cleaned in 2020. The second highest per mile aluminum concentration was at Hidden Beach, a popular walk-in and boat-in public beach also characterized by rocky substrate.*

Crystal Bay Basin: W Incline/ Incline Beach, E Incline/ NV State Park, and Hidden Beach

W Incline/ Incline Beach was the second most litter polluted region cleaned in 2020 (Table 1, Fig. 9). Of all locations cleaned in Crystal Bay, W Incline/Incline Beach had the most plastic based on weight per mile, and the second most plastic accumulation across the 7.1 mile cleanup (Table 3). Plastic in the W Incline region totaled 81 lbs. and was dominated by "other" items such as plastic fragments and PVC pipe. While numerous plastic recreational items were removed, their cumulative weight contribution is small compared to "other" items.

W Incline dive segments 6.2A and 6.3A, just northwest of Incline Beach had slightly above average litter (lbs. per mile) compared to all locations cleaned (Table 2 and 3). Dive segments along Incline Beach (6.1A, 4.3A, 4.3B, and 4.1B) had below average litter accumulations by -0.7, -1.1, -1.2 and -0.8 standard deviations, respectively (Table 2 and 3). These dive segments (4.1B, 4.3A, 4.3B, and 6.1–3A) are characterized by sandy lakebed. Notably, segments 4.3B and 4.3A were the least and second least polluted dive segments, respectively, and are characterized by sandy lakebed substrate along private residences. Segments 6.2A and 6.3A had near average litter concentrations and are located alongside private property. The lakebed bathymetry in this region dips also relatively rapidly into the deeper Crystal Bay basin.

Incline Beach and Ski Beach, both popular recreational beaches for locals and Incline visitors, are adjacent to cleanup dive segment 6.1A. This local segment is - 0.7 standard deviations below the average litter concentration on a weight per mile basis relative to all segments cleaned in 2020. It is important to note that segment 6.1A is also characterized by sandy substrate, which may not be conducive to litter accumulation.

The E Incline/ NV State Park (dive day 4) region had around average litter accumulation (Fig. 7, Table 1- 3). This region was dominated by metal and wood litter (Fig. 10). Metal litter was primarily comprised of "other" items and metal fragments. Ten lbs. of Al drink cans, totaling 113 cans, were also removed (Fig. 11 and 12).

The majority of litter in this region was concentrated in dive segments 4.2A and 4.2B (Fig. 9, Table 2 and 3). Segments 4.2A and 4.2B were the second and third most litter polluted locales, respectively, based on weight per mile and are characterized by rocky shoreline along private property. Dive segments from 4.2B south, including 4.2B, 4.2A, 4.1A, 5.1A, and 5.2A (NV State Park and Hidden Beach) are a mix of rock and sand substrate with relatively steep sloped bathymetry that descends into the deep-water basin. Segments 4.1A and 5.2 A have average litter concentrations and 5.1A is below average (Table 2). Hidden Beach dive segments (dive day 5) were dominated by wood, especially processes timber (48 lbs., Fig. 10, Table 3).

Overall, these data are consistent with the hypothesis that rocky substrate acts as litter accumulation zones, or sinks. Rocky shorelines near populated and popular shorelines are particularly prone to litter accumulation and make up the top three most litter polluted segments cleaned in 2020. Bathymetric slope combined with lakebed substrate may also play a role in nearshore litter accumulation, where low sloping rocky coves are particularly to litter accumulation.

South Tahoe: Elk Point/ NV Beach, and Zephyr Cove

Cleanup dive regions along Nevada's southwestern shorelines at Elk Point/NV beach and Zephyr Cove had the lowest and second lowest litter concentrations of all regions cleaned in 2020 (Fig. 10, Table 1). Dive segments therein had average or below average litter concentrations compared to all other segments (Table 2 and 3). Litter in these two regions was dominated by metal, glass and ceramic, and rubber (Fig. 10, Table 3). Metal was largely comprised of other items, such as pipes and fragments. Glass and ceramic at Zephyr Cove included construction materials. Elk Point/NV Beach had the highest rubber concentration (Fig. 10), which was due to the presence of tires totaling 85 lbs (3.5 tires). While there are numerous items that reflect recreational inputs, such as rope, clothing, recreational equipment (plastic), Al cans, and bottles, these do not comprise the majority of the litter by weight.

The lakebed substrate along both Elk Point/ NV Beach and Zephyr Cove is predominantly sand and has relatively low angle bathymetry that slopes gradually into deeper waters. Zephyr cove has some rocky outcrops. The most littered segments in these two regions (1.2A and 1.1A, Table 2) are directly adjacent to NV Beach and NV Beach Campground (Fig. 5) and are average compared to all segments cleaned in 2020. These data are consistent with the hypothesis that litter accumulation occurs near popular and populated shorelines, yet is less prevalent along lakebed characterized by sandy substrate due to its inability to ensnare and accumulate litter. It is possible that these regions are litter sources and that the litter is transported away from the point of entry by currents or wind.

Table 3 Weight per mile for each litter material type at each dive segment cleaned. Data are sorted based on total lbs per mile removed. Total lbs. per mile removed is prenominal driven by the amount of metal removed and secondarily correlated to plastic litter. Localized stretches along E and W Incline had the highest litter concentration.

Dive Data			Total Litter Removed			Litter by Material (lbs/mile)									Non-Collection Items (n/mile)	
Dive Number	Location	Distance (mi)	Total (lbs.)	Total (lbs/mi)	Non-Metal (lbs/mi)	Plastic	Foamed Plastic	Cloth	Glass & Ceramic	Metal	Paper & Cardboard	Rubber	Wood	Other	Heavy Lift Items	Hot Spots
3.2B	S Sand Harbor	0.15	164.3	1079.0	628.7	346.3	105.1	32.8	92.1	450.3	0.0	26.0	26.3	0.0	7	0
4.2B	E Incline/ NV State Park	0.27	159.3	600.5	241.9	21.2	0.0	20.0	42.1	358.6	0.0	4.0	154.6	0.0	15	8
4.2A	E Incline/ NV State Park	0.16	64.4	395.6	209.0	109.4	0.0	31.7	33.2	186.6	0.0	4.0	30.7	0.0	12	12
3.2A	S Sand Harbor	0.11	42.2	395.0	108.6	27.4	0.0	19.6	34.1	286.4	0.0	27.5	0.0	0.1	0	28
3.3A	S Sand Harbor	0.16	58.9	377.5	176.6	93.9	0.0	39.5	20.7	200.8	0.0	21.4	0.7	0.4	0	19
6.2A	W Incline/ Incline Beach	0.46	167.0	366.8	152.0	131.7	0.0	3.4	5.5	214.8	0.0	6.8	4.6	0.0	7	0
1.2A	Elk Point/ NV Beach	0.24	83.0	344.7	251.6	0.3	0.0	10.3	1.7	93.1	0.0	239.4	0.1	0.0	15	0
6.3A	W Incline/ Incline Beach	0.48	159.9	336.0	98.7	65.3	0.0	0.8	9.9	237.3	0.1	10.0	12.6	0.1	13	0
1.1A	Elk Point/ NV Beach	0.34	108.9	316.9	217.9	56.5	0.0	8.4	72.7	99.0	0.3	79.2	0.2	0.5	38	0
5.2A	Hidden Beach	0.28	88.4	312.3	266.4	74.3	0.0	13.7	8.9	45.9	0.0	4.7	162.6	2.2	18	7
4.1A	E Incline/ NV State Park	0.13	40.8	309.6	80.2	25.0	0.0	14.5	17.4	229.4	0.0	14.8	8.6	0.0	15	15
3.1B	S Sand Harbor	0.27	82.8	302.0	225.3	114.6	0.0	67.9	10.0	76.7	0.0	6.2	5.1	21.6	4	4
3.1A	S Sand Harbor	0.19	57.7	300.8	127.1	20.9	0.0	15.6	40.2	173.6	0.0	41.1	0.0	9.4	10	5
2.2B	Zephyr Cove	0.40	93.5	234.1	44.7	6.1	0.0	15.6	21.3	189.4	0.0	1.7	0.0	0.0	3	0
2.1A+B	Zephyr Cove	0.78	168.3	215.7	146.3	27.2	0.0	37.3	54.2	69.4	0.0	27.6	0.0	0.0	19	1
3.3B	S Sand Harbor	0.16	21.8	133.3	83.0	15.8	0.0	34.2	30.0	50.3	0.0	2.1	0.0	0.9	6	0
5.1A	Hidden Beach	0.31	39.9	130.3	101.8	9.3	0.0	29.4	47.4	28.5	0.0	7.9	7.7	0.1	0	7
6.1A	W Incline/ Incline Beach	0.41	45.4	109.8	32.4	2.4	0.0	29.5	0.1	77.4	0.0	0.4	0.0	0.1	22	0
2.2A	Zephyr Cove	0.30	28.2	95.2	89.5	5.7	0.0	0.0	78.4	5.7	0.0	1.6	3.8	0.0	7	0
4.1B	E Incline/ NV State Park	0.36	33.2	93.0	38.9	1.7	0.0	7.4	1.8	54.1	0.0	0.0	28.0	0.0	11	0
1.2B	Elk Point/ NV Beach	0.31	25.7	82.8	41.2	27.3	0.0	9.4	3.6	41.6	0.0	0.8	0.0	0.1	13	6
1.1B	Elk Point/ NV Beach	0.40	16.6	41.0	25.7	7.5	0.0	1.2	2.5	15.3	0.2	10.4	3.7	0.2	8	0
4.3A	E Incline/ NV State Park	0.27	7.9	28.9	19.9	0.7	0.0	15.3	0.0	8.9	0.0	3.9	0.0	0.0	37	0
4.3B	E Incline/ NV State Park	0.16	0.3	2.0	2.0	0.5	0.0	0.0	0.2	0.0	0.0	1.1	0.1	0.0	18	0
	Total	**7.1**	**1758.3**	-	-	-	-	-	-	-	-	-	-	-	-	-
	Average (per mi.)	**0.3**	**73.3**	**275.1**	**142.1**	**49.6**	**4.4**	**19.1**	**26.2**	**133.1**	**0.0**	**22.6**	**18.7**	**1.5**	**12.4**	**4.7**

Dive Day 1
Elk Cove/NV Beach

Figure 12 *Litter removed during dive day 1, Elk Point/NV Beach.*

Dive Day 2
Zephyr Cove

Figure 13 *Litter retrieved during dive day 2, along Zephyr Cove.*

Dive Day 3
Sand Harbor

Figure 14 Litter removed from Sand Harbor on dive day 3.

Dive Day 4
East Incline/NV State Park

Figure 15 *Litter removed from E Incline/NV State Park during dive day 4.*

Dive Day 5
Hidden Beach

Figure 16 *Litter removed from Hidden Beach on dive day 5.*

Dive Day 6
W Incline/Incline Beach

Figure 17 *Litter removed from W Incline/Incline Beach during dive day 6.*

Evidence of Litter Degradation in Lake Tahoe

Although submerged litter items persist for many years, its ongoing degradation can introduce a steady flow of micro-trash and toxins into the surrounding waters. It is well known that the abrasion and degradation of plastic and rubber in the environment contributes to the production and accumulation of microplastics (particles < 5 mm). Researchers at UC-Davis TERC and DRI have identified the presence of microplastics in Lake Tahoe's surface water (Harrold et al., 2019) and beaches (UC Davis, 2019). It is likely that the degradation of submerged litter contributes to microplastic accumulation in the lake (Davidson, 2020). Other research has shown plastic and rubber to contain and leach organic toxins (e.g. BPA, PCBs, etc.; e.g. Bergman et al., 2015; GESAMP, 2019) and heavy metals (e.g. zinc from tires, lead, cadmium; Bergmann et al., 2015; Nakashima et al., 2012; Wagner et al., 2018). Litter itself, as well as plastic and rubber degradation products, including microplastics and chemical leachates, have been shown to negatively impact the health of aquatic fauna throughout the food chain (e,g, Bejgarn, S et al., 2015; Bergmann et al., 2015; Cheshire et al., 2009; Ryan, 2019; Wagner, 2018).

The 2020 cleanup dives removed 308 lbs. of plastic, 16 lbs. of foamed plastic, and 149 lbs. of rubber, including 110 lbs. of tires, from 7.1 miles of Lake Tahoe's nearshore lakebed. Many of the removed litter items show clear signs of degradation (Fig. 13 - 18). CUTL found direct evidence of microplastic production when divers pulled disintegrating tires from the lakebed (Fig. 1). Meso- and microplastics were also observed after sorting and categorizing larger litter items, indicating the ongoing degradation and breakdown of submerged plastic and rubber litter in Lake Tahoe. If left in place, the ongoing degradation of submerged litter, particularly plastic and rubber, will continue to slowly release microplastics and leachates into Lake Tahoe's azure waters.

Conclusions

In 2020 CUTL executed cleanup dives along 7.1 miles of Lake Tahoe's Nevada shoreline and removed 1758 pounds of litter. Regional and locational litter accumulations based on weight per mile removed, indicate that shoreline population and popularity as well as lakebed substrate play a role in the location and types of litter accumulation. Namely, rocky shoreline and lakebed tend to accumulate the most litter, particularly when located near public and popular beaches. In contrast, shoreline regions with sandy lakebed accumulate less litter, though accumulation depends on nearby population and site popularity. These data also suggest that litter sources, as well as transport processes both from land to water (e.g. at popular sandy beaches), and within the lake via currents or wind (e.g. from sandy beaches to rocky accumulation zones) may dictate where litter accumulates along Lake Tahoe's NV shoreline. More work is required to glean additional insight on lake-wide litter accumulation patterns and in other regions of the lake such as east shore versus west shore litter distributions.

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Appendix A

Table A1 Litter removed and non-collection items recorded along the 6 miles of Nevada nearshore lakebed.

Dive Data			Total Litter Removed		Litter by Material (lbs)									Non-Collection Items (n)	
Dive Number	Location	Distance (mi)	Total (lbs)	Total (lbs/mi)	Plastic	Foamed Plastic	Cloth	Glass & Ceramic	Metal	Paper & Cardboard	Rubber	Wood	Other	Heavy Lift Items	Hot Spots
1.1A	Elk Point/ NV Beach	0.34	108.9	316.9	19.4	0.0	2.9	25.0	34.0	0.1	27.2	0.1	0.2	13	0
1.1B	Elk Point/ NV Beach	0.40	16.6	41.0	3.0	0.0	0.5	1.0	6.2	0.1	4.2	1.5	0.1	2	0
1.2A	Elk Point/ NV Beach	0.24	83.0	344.7	0.1	0.0	2.5	0.4	22.4	0.0	57.6	0.0	0.0	6	0
1.2B	Elk Point/ NV Beach	0.31	25.7	82.8	8.5	0.0	2.9	1.1	12.9	0.0	0.3	0.0	0.0	4	2
2.1A+B	Zephyr Cove	0.78	168.3	215.7	21.2	0.0	29.1	42.2	54.2	0.0	21.6	0.0	0.0	15	1
2.2A	Zephyr Cove	0.30	28.2	95.2	1.7	0.0	0.0	23.2	1.7	0.0	0.5	1.1	0.0	2	0
2.2B	Zephyr Cove	0.40	93.5	234.1	2.4	0.0	6.3	8.5	75.7	0.0	0.7	0.0	0.0	1	0
3.1A	S Sand Harbor	0.19	57.7	300.8	4.0	0.0	3.0	7.7	33.3	0.0	7.9	0.0	1.8	2	1
3.1B	S Sand Harbor	0.27	82.8	302.0	31.4	0.0	18.6	2.7	21.0	0.0	1.7	1.4	5.9	1	1
3.2A	S Sand Harbor	0.11	42.2	395.0	2.9	0.0	2.1	3.6	30.6	0.0	2.9	0.0	0.0	0	3
3.2B	S Sand Harbor	0.15	164.3	1079.0	52.7	16.0	5.0	14.0	68.6	0.0	4.0	4.0	0.0	1	0
3.3A	S Sand Harbor	0.16	58.9	377.5	14.7	0.0	6.2	3.2	31.4	0.0	3.3	0.1	0.1	0	3
3.3B	S Sand Harbor	0.16	21.8	133.3	2.6	0.0	5.6	4.9	8.2	0.0	0.3	0.0	0.1	1	0
4.1A	E Incline/ NV State Park	0.13	40.8	309.6	3.3	0.0	1.9	2.3	30.2	0.0	1.9	1.1	0.0	2	2
4.1B	E Incline/ NV State Park	0.36	33.2	93.0	0.6	0.0	2.6	0.6	19.3	0.0	0.0	10.0	0.0	4	0
4.2A	E Incline/ NV State Park	0.16	64.4	395.6	17.8	0.0	5.2	5.4	30.4	0.0	0.7	5.0	0.0	2	2
4.2B	E Incline/ NV State Park	0.27	159.3	600.5	5.6	0.0	5.3	11.2	95.1	0.0	1.1	41.0	0.0	4	2
4.3A	E Incline/ NV State Park	0.27	7.9	28.9	0.2	0.0	4.2	0.0	2.4	0.0	1.1	0.0	0.0	10	0
4.3B	E Incline/ NV State Park	0.16	0.3	2.0	0.1	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	3	0
5.1A	Hidden Beach	0.31	39.9	130.3	2.9	0.0	9.0	14.5	8.7	0.0	2.4	2.4	0.0	0	2
5.2A	Hidden Beach	0.28	88.4	312.3	21.0	0.0	3.9	2.5	13.0	0.0	1.3	46.0	0.6	5	2
6.1A	W Incline/ Incline Beach	0.41	45.4	109.8	1.0	0.0	12.2	0.0	32.0	0.0	0.2	0.0	0.0	9	0
6.2A	W Incline/ Incline Beach	0.46	167.0	366.8	60.0	0.0	1.5	2.5	97.8	0.0	3.1	2.1	0.0	3	0
6.3A	W Incline/ Incline Beach	0.48	159.9	336.0	31.1	0.0	0.4	4.7	112.9	0.0	4.8	6.0	0.0	6	0
	Total	**7.1**	**1758.3**	**-**	**308.2**	**16.0**	**130.7**	**181.5**	**842.0**	**0.2**	**148.8**	**121.8**	**9.0**	**96.0**	**21.0**
	Average	**-**	**73.3**	**275.1**	**12.8**	**0.7**	**5.4**	**7.6**	**35.1**	**0.0**	**6.2**	**5.1**	**0.4**	**4.0**	**0.9**

CLEAN UP THE LAKE

Table A2 UNEP/IOC Litter sorting categorization (Cheshire, 2009) and CUTC/DRI/TERC refinements (in square brackets) implemented in the LTLP 20-01 cleanup.

No.	Material	Code	Litter type
1	Plastic	PL01	Bottle caps & lids
2	Plastic	PL02	Bottles < 2 L (#)
3	Plastic	PL03	Bottles (#), drums, jerrycans & buckets > 2 L
4	Plastic	PL04	Knives, forks, spoons, straws, stirrers, (cutlery)
5	Plastic	PL05	Drink package rings, six-pack rings, ring carriers
6	Plastic	PL06	Food containers (fast food, cups, lunch boxes & similar) [plates, tableware, any food packaging inc. bags]
7	Plastic	PL07	Plastic bags (opaque & clear) [other non-food packaging]
8	Plastic	PL08	Toys & party poppers [recreational equipment]
9	Plastic	PL09	Gloves [sunglassess, hair clips, other accessories]
10	Plastic	PL10	Cigarette lighters [vape devices]
11	Plastic	PL11	Cigarettes, butts & filters
12	Plastic	PL12	Syringes
13	Plastic	PL13	Baskets, crates & trays
14	Plastic	PL14	Plastic buoys
15	Plastic	PL15	Mesh bags (vegetable, oyster nets & mussel bags)
16	Plastic	PL16	Sheeting (tarpaulin or other woven plastic bags, palette wrap)
17	Plastic	PL17	Fishing gear (lures, traps & pots)
18	Plastic	PL18	Monofilament line
19	Plastic	PL19	Rope
20	Plastic	PL20	Fishing net
21	Plastic	PL21	Strapping
22	Plastic	PL22	Fibreglass fragments
23	Plastic	PL23	Resin pellets
24	Plastic	PL24	Other (specify) [a. PVC pipe, b. plastic fragments c. other]
25	Foamed Plastic	FP01	Foam sponge
26	Foamed Plastic	FP02	Cups & food packs
27	Foamed Plastic	FP03	Foam buoys
28	Foamed Plastic	FP04	Foam (insulation & packaging)
29	Foamed Plastic	FP05	Other (specify)
30	Cloth	CL01	Clothing, shoes, hats & towels
31	Cloth	CL02	Backpacks & bags
32	Cloth	CL03	Canvas, sailcloth & sacking (hessian)
33	Cloth	CL04	Rope & string
34	Cloth	CL05	Carpet & furnishing
35	Cloth	CL06	Other cloth (including rags) [Masks]
36	Glass & ceramic	GC01	Construction material (brick, cement, pipes)
37	Glass & ceramic	GC02	Bottles & jars [a. whole bottles/jars (#), b. broken bottles/jars]
38	Glass & ceramic	GC03	Tableware (plates & cups)
39	Glass & ceramic	GC04	Light globes/bulbs
40	Glass & ceramic	GC05	Fluorescent light tubes
41	Glass & ceramic	GC06	Glass buoys
40	Glass & ceramic	GC07	Glass, ceramic fragments [unknown source]
43	Glass & ceramic	GC08	Other (specify)

No.	Material	Code	Litter type
44	Metal	ME01	Tableware (plates, cups & cutlery)
45	Metal	ME02	Bottle caps, lids & pull tabs
46	Metal	ME03	Aluminum drink cans [Count]
47	Metal	ME04	Other cans (< 4 L)
48	Metal	ME05	Gas bottles, drums & buckets (> 4 L)
49	Metal	ME06	Foil wrappers
50	Metal	ME07	Fishing related (sinkers, lures, hooks, traps & pots)
51	Metal	ME08	Fragments [unknown source]
52	Metal	ME09	Wire, wire mesh, barbed wire [metal cording and cable]
53	Metal	ME10	Other (specify), including appliances [a. (#) anchors , b. other]
54	Paper/cardboard	PC01	Paper (including newspapers & magazines)
55	Paper/cardboard	PC02	Cardboard boxes & fragments [non-food packaging]
56	Paper/cardboard	PC03	Cups, food trays, food wrappers, cigarette packs, drink containers
57	Paper/cardboard	PC04	Tubes for fireworks
58	Paper/cardboard	PC05	Other (specify)
59	Rubber	RB01	Balloons, balls (#) & toys
60	Rubber	RB02	Footwear (flip-flops)
61	Rubber	RB03	Gloves
62	Rubber	RB04	Tires (#)
63	Rubber	RB05	Inner-tubes and rubber sheet
64	Rubber	RB06	Rubber bands [hair ties]
65	Rubber	RB07	Condoms
66	Rubber	RB08	Other (specify)
67	Wood	WD01	Corks
68	Wood	WD02	Fishing traps and pots
69	Wood	WD03	Ice-cream sticks, chip forks, chopsticks & toothpicks [wood utensils]
70	Wood	WD04	Processed timber and pallet crates [lumber]
71	Wood	WD05	Matches & fireworks
72	Wood	WD06	Other (specify)
73	Other	OT01	Paraffin or wax
74	Other	OT02	Sanitary (nappies, cotton buds, tampon applicators, toothbrushes) [toiletries]
75	Other	OT03	Appliances & Electronics
76	Other	OT04	Batteries (torch type)
77	Other	OT05	Other (specify) [residual meso-trash, e.g. ~ < 5 cm]