Scopan Lake Brook Trout and Landlocked Salmon Radio Telemetry Study

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SUMMARY

Scopan Lake is one of few lakes of its size in Northern Maine that does not support self-sustaining populations of brook trout (BKT) and landlocked salmon (LLS). It is impounded by the 1.5MW Squa Pan Hydroelectric Project, owned and operated by Algonquin Northern Maine Generating Company (Algonquin). The dam is licensed by the Federal Energy Regulatory Commission (FERC) through 2021 and is used for power generation during peak electricity demand in the winter and water storage for two other Algonquin projects downstream on the Aroostook River. After November 30th, the lake is drawn down up to ten feet to generate power at downstream projects. It is possible that winter drawdown may be dewatering brook trout and landlocked salmon spawning sites.

The objective of this study was to capture and surgically implant radio transmitters into at least 15 wild brook trout and landlocked salmon and track them around the lake to their spawning locations to determine whether winter drawdowns would affect their spawning sites. Fish were sampled for 22 days using trapnets at three locations near the mouths of tributary streams - West Inlet, Bogan Brook, and Cold Spring Brook. During this period, only one wild brook trout was captured. Due to the lack of wild fish, it was necessary to use hatchery fish as surrogates for wild trout and salmon. On October 5th, 250 fall yearling (FY) brook trout were stocked in the lake and radio transmitters were surgically implanted into 10 of these fish. On October 23rd, 200 FY landlocked salmon were stocked, and radio transmitters were surgically implanted into five of these fish. Additionally, radio transmitters were implanted into three splake that were captured in trapnets to provide practice subjects for tracking as well as some additional habitat use information.

Tracking of radio tagged fish began on October 12th and continued until November 12th when ice formation prevented further sampling. The hatchery fish were expected to spawn around November 10-12th based on hatchery schedules for stripping operations at the Enfield State Fish Hatchery. Several fish were observed entering tributaries in early November, but five of these fish died in tributaries likely having been preyed upon by birds or mammals. Three tagged fish were never found after being released, and another three were not found during the final two weeks of tracking. At least 5 and as many as 11 of the 15 tagged fish died within one month of stocking.

The lack of wild trout and salmon in Scopan Lake and the high mortality of hatchery brook trout hampered efforts to examine the main objective of this study – whether winter drawdown impacts trout and salmon spawning sites. Earlier than normal ice cover in November 2018 shortened the field season significantly; however, most of the study fish were confirmed or assumed dead by this point. Four FY salmon remained alive but showed no signs of spawning behavior (i.e., entering tributary streams) when tracking ceased on November 12th. It remains unknown whether the winter drawdown associated with hydroelectric operations is impacting salmonid spawning success.

The current stocking program being carried out by Maine Inland Fisheries and Wildlife is the only option to provide sport fishing opportunity at Scopan Lake at this time. Maine IF&W stocks out approximately 1,000 FY splake each year at a cost of about $8.50 per fish and these

fish survive well and are caught by anglers during the winter season and part of the summer season. There is some survival of splake through their first summer in the lake. Extra hatchery brook trout have been stocked in recent years, and it was assumed these fish were surviving and being caught by anglers. However, the observed high mortality of FY brook trout in this study was surprising and suggests that stocking FY brook trout here is not cost-effective. Until factors keeping wild trout and salmon populations low or non-existent at Scopan Lake are fully understood, the splake stocking program should be continued. Brook trout and landlocked salmon stocking should be further evaluated through winter and summer creel surveys to determine whether these programs are cost-effective.

KEY WORDS: BROOK TROUT, LANDLOCKED SALMON, SPLAKE, SURVIVAL, RADIO TELEMETRY, HYDROELECTRIC POWER, HATCHERY FISH SURVIVAL, HATCHERY FISH MOVEMENT

ABSTRACT

Scopan Lake is one of few large lakes in Aroostook County that does not support sport fisheries for wild brook trout (*Salvelinus fontinalis*; BKT) and landlocked salmon (*Salmo salar*; LLS). The lake is impounded by the Squa Pan Hydroelectric Project (FERC Project No. 2368), a 1.5 MW hydropower dam owned and operated by Algonquin Northern Maine Generating Co. (Algonquin). Some aspects of hydroelectric operations, including winter drawdown, may be contributing to low reproductive success of salmonid fishes. The objective of this study was to determine whether winter drawdown is affecting spawning sites of trout and salmon using radio telemetry. Fish were sampled using trapnets at three locations for 22 days in September-October of 2018, yielding only one wild brook trout. Thus, it was necessary to use hatchery trout and salmon as surrogates to wild fish in the study. Radio-tagged fish were located 110 times in 109.1 hrs of tracking time spanning one month (October 12th-November 12th).

Movement varied between individual fish as well as species. Four trout and one salmon moved into tributaries, presumably staging to spawn, but were confirmed dead by the end of tracking. Three trout were never found after being stocked, and three trout were not found for the final two weeks of tracking. Three splake that had been living in the lake for at least 11 months were radio-tagged in late September and remained alive at the end of the study. This study was unable to address the question of whether winter drawdown is impacting salmonid reproductive success in Scopan Lake. However, the observed mortality of hatchery fish may explain why certain hatchery programs have been unsuccessful in establishing wild salmonid fisheries. Despite the high cost, current hatchery programs that include annual stocking of large yearling splake should continue until factors precluding wild salmonid populations can be identified and resolved.

INTRODUCTION

Scopan Lake is a 5,043 acre (2041 hectares) lake in Aroostook County, Maine, and is impounded by Squa Pan Dam, a hydroelectric power project owned and operated by Algonquin Northern Maine Generating Company (Algonquin). The project is licensed by the Federal Energy Regulatory Commission (FERC) through 2021 under the name “Squa Pan Project” (FERC project no. 2368). Despite its large size, Scopan Lake is one of few waterbodies in the region that does not support fishable populations of wild brook trout (*Salvelinus fontinalis*; hereafter BKT or trout) and landlocked Atlantic salmon (*Salmo salar*; hereafter LLS or salmon).

It is possible that some factors related to hydropower production may be limiting salmonid reproductive success and abundance in the lake, including winter lake level drawdowns, fish access to tributary habitat, and lack of upstream fish passage at the dam. Many lakes in northern Maine like Scopan do support wild populations of lake dwelling trout and salmon, none of which have hydropower production associated with them. Numerous tributaries to Scopan Lake have suitable habitat for all life stages of brook trout, and at least one tributary has suitable spawning and rearing habitat for salmon based on Maine Department of Inland Fisheries and Wildlife (IF&W) Surveys. Small populations of trout are present in the tributaries, but these populations likely consist of relatively small fish averaging 5-7 inches in length, and

thus do not support a recreational fishery. It is hypothesized that winter lake drawdowns may be dewatering salmonid spawning sites, thereby lowering reproductive success of lake dwelling salmonids. However, there have been no studies evaluating the impact of project operations on salmonid reproduction in the lake.

Other factors that might be limiting wild trout and salmon production are lack of late-summer thermal refugia within the lake and large populations of competing, non-sport fish such as brown bullhead (*Ameirus nebulosis*; BUL) yellow perch (*Perca flavescens*; YLP), and white sucker (*Catostomus commersonii*; WHS). Observed summer survival of splake (*Salvelinus fontinalis X Salvelinus namaycush*; SPK) indicates that water quality is sufficient to allow summer survival of other salmonid fishes. Splake are a hybrid of brook trout and lake trout (*Salvelinus namaycush)* and are stocked annually by IF&W. They have water quality requirements similar to their two parent species, and summer survival of splake indicates that water quality is sufficient to allow survival of other salmonid species. Survival of splake through summer months has been documented in routine winter creel surveys by IF&W. Additionally, many other lakes in northern Maine have large populations of competing non-sport fishes, and still support fishable populations of trout and salmon. For decades now, various stocking programs by IF&W have been used to provide sport fisheries for salmonids in the absence of wild brook trout and landlocked salmon fisheries. These stocking programs have been unsuccessful in establishing self-sustaining wild fisheries in Scopan Lake.

Many factors may be inhibiting the reproductive success of trout and salmon in Scopan Lake. The objective of this study was to use radio telemetry to track the movement of trout and salmon throughout Scopan Lake and its tributaries to identify spawning locations and determine whether winter drawdowns are dewatering spawning sites.

STUDY AREA

Scopan Lake is in T10 R4 WELS, T11 R4 WELS, Masardis, and Ashland, Aroostook County, and has a surface area of 5,043 acres (2,041 hectares; Figure 1). It is impounded by the 1.5 MW Squa Pan Hydroelectric Project (Project No. 2368) owned and operated by Algonquin Northern Maine Generating Company (Algonquin). The dam was built in 1927-1928, is 35 feet high, and has a radial gate height of 13.5 ft. Lake levels are typically maintained between 11-13 ft above the crest of the spillway (elevation 590.0 ft) for most of the year. The dam is equipped with a vertical turbine with a generating capacity of 1.5 MW, but the reservoir is used primarily for water storage for downstream hydroelectric projects. An annual drawdown of up to 10 feet after November 30th is used to provide water for peak demand power generation at the Squa Pan Project. Additionally, power is generated 54 river miles downstream on the Aroostook River at Algonquin's Caribou Dam (Project No. 2367) and 70 river miles downstream on the Aroostook River at Tinker Dam in New Brunswick, Canada. The dam does not have fish passage, eliminating upstream fish movement from Scopan Stream.

Scopan Lake provides habitat for a wide variety of fish species. The higher water levels resulting from the dam substantially increased the amount of littoral habitat in the lake. Because of this, the lake supports large populations of non-sport fishes which compete with sport fishes such as brook trout and landlocked salmon. Occasionally, wild brook trout and

landlocked salmon are caught in the winter sport fishery (IF&W, unpublished data), indicating that there are small populations of both species. However, the sport fishing focus is primarily on splake. Rainbow smelt (*Osmerus mordax*; SLT) support a popular hand-line fishery during winter months and a dip-net fishery during the spring spawning run. Other common fish species in the lake include brown bullhead, yellow perch, white sucker, and redbreast sunfish (*Lepomis auritis*; RBS). It is believed that brook trout and landlocked salmon utilize the lake's tributaries for spawning (Figure 1).

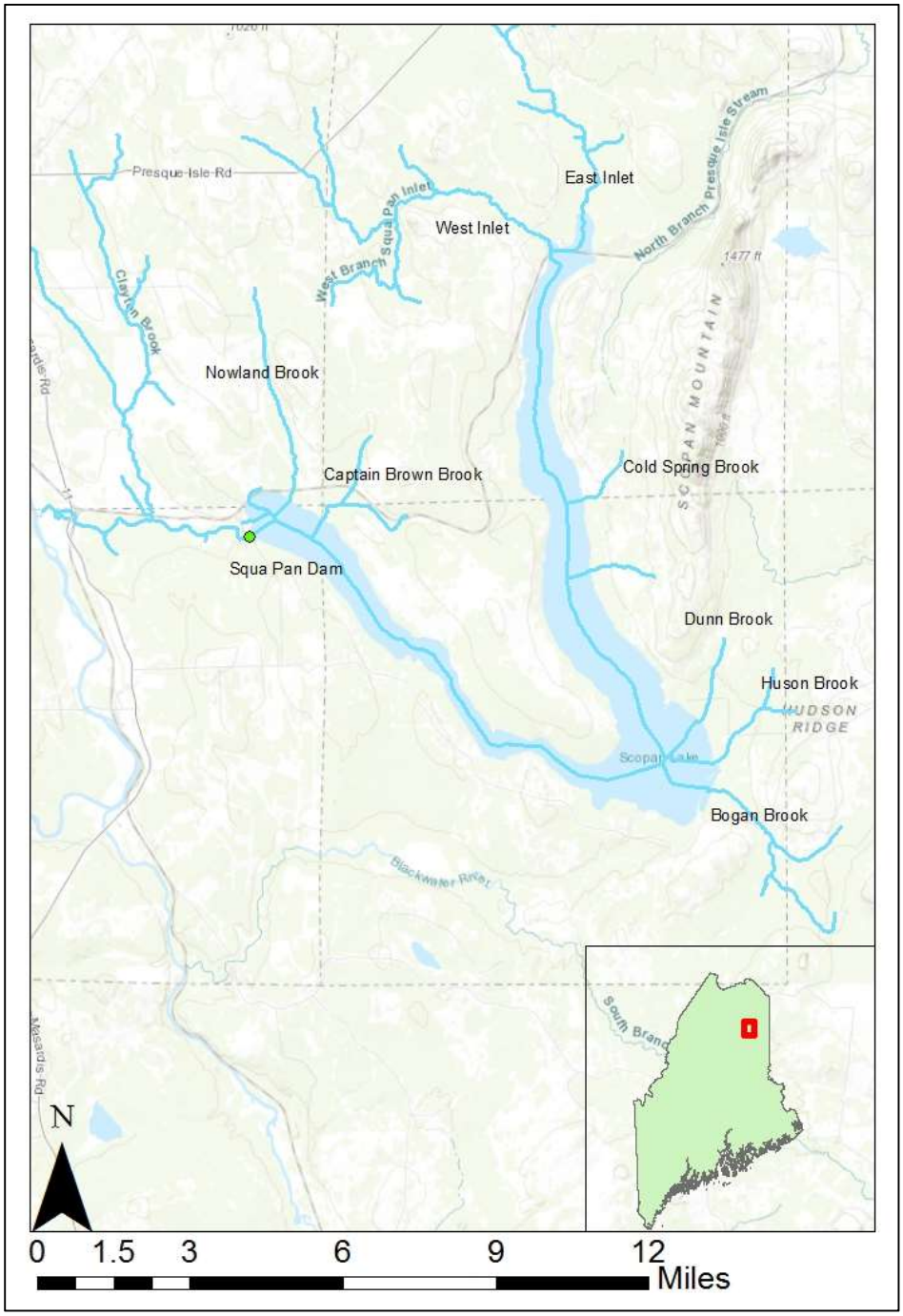

Figure 1. Location of Scopan Lake, tributaries and the Squa Pan Hydroelectric Project.

Water quality in Scopan Lake is considered marginal for salmonids and is potentially a contributing factor in the lack of wild trout and salmon. Mean and maximum depths of Scopan Lake are 21 ft (6.4 m) and 58 ft (17.7 m) respectively, and because of the relatively shallow depth and mixing by wind, the lake often does not stratify in the summer. Thus, water temperatures can become unsuitable for salmonid survival during summer months. However, habitat refugia in or near tributary streams or groundwater influences appear to be adequate for some summer survival when much of the lake is otherwise unsuitable. Splake commonly survive summer months as documented by carry-over of age classes observed during winter creel surveys (IF&W, unpublished data). The summer survival of splake, which have water quality requirements intermediate to brook trout and lake trout, indicates that some late-summer thermal refugia exists in the lake. Additionally, it is believed that small populations of wild brook trout and possibly landlocked salmon survive and reproduce in and near the tributaries of Scopan Lake.

Since wild fish numbers have been inadequate to support a sport fishery, IF&W has used fish stocking to provide fishing opportunities in the lake. Landlocked salmon, brook trout, and lake trout have all been stocked over the past 60 years. The brook trout and lake trout stocking lasted only a few years, but in recent years unscheduled brook trout (extra hatchery fish) have been stocked intermittently. A limited number of salmon continue to be stocked every four years. A splake stocking program began in 1990 and continues at an annual rate of 1.4 fish/acre.

METHODS

Fish Sampling

Trapnets were installed at three locations in the lake to capture brook trout and landlocked salmon. Nets were placed near the mouths of West Inlet (net 1), Bogan Brook (net 2), and Cold Spring Brook (net 3; Figure 2). Trapnets are a non-lethal sampling method designed to capture fish moving along the shoreline in relatively shallow water. Nets 1 and 2 were of "Maine Brook Trout" design and net 3 was an "Oneida Lake" design (Table 1).

Table 1. Trapnet design and dimensions.

Net	Design	Lead Length (ft)	Depth (ft)	Mesh Size (in)	Wing length (ft)	Box Dimensions (ft; Length X Depth X Width)
1	Maine Brook Trout	65	4.8	3/8	20	4X4X4.5
2	Maine Brook Trout	60	5.9	3/8	20	4X4X4.5
3	Oneida Lake	80	6.5	1/2	18	4X4X4

Nets were set in late September and in locations where salmonids would likely be moving along the shoreline searching for spawning locations. To examine fish assemblage, 30-50 fish of each species captured in each net were counted, weighed (oz), and measured (total length; in). Once 30-50 individuals of each species were weighed and measured at each net, individuals of each species were counted, and a cumulative weight was taken for each species at each net. All three nets were removed from the lake on October 15th when it became apparent, based on low catch rates, that wild trout and salmon catches would not be adequate to fulfill the need of the radio telemetry study.

Fish Tagging

The objective of this study was to implant radio transmitter tags in wild brook trout and landlocked salmon and track their movements around the lake to identify spawning locations. Due to the lack of wild trout and salmon, hatchery-reared fall yearling (FY) brook trout and landlocked salmon were used as surrogates for wild fish. On October 5th, IF&W stocked 250 FY brook trout (radio-tagged, N = 10), and on October 23rd, IF&W stocked 200 landlocked salmon (radio-tagged, N = 5) in Scopan Lake at the boat launch at Walker Siding. IF&W biologists surgically implanted 15 radio transmitters (Advanced Telemetry Systems model F1580) into 10 brook trout (5 male and 5 female, average total length 13.2 in) and 5 landlocked salmon (all males, average total length 15 in). Radio tags weighed 0.13 oz (3.6 g) and had a warrantied battery life of 220 days. In addition, on September 28th radio transmitters were implanted into three splake that were captured the previous day in net 2 at Bogan Brook. The tags used in the splake were Advanced Telemetry Systems model F1835 left over from a previous study. The splake tags had adequate battery life and were used here to provide “practice” subjects for tracking, and secondarily provide some habitat use information.

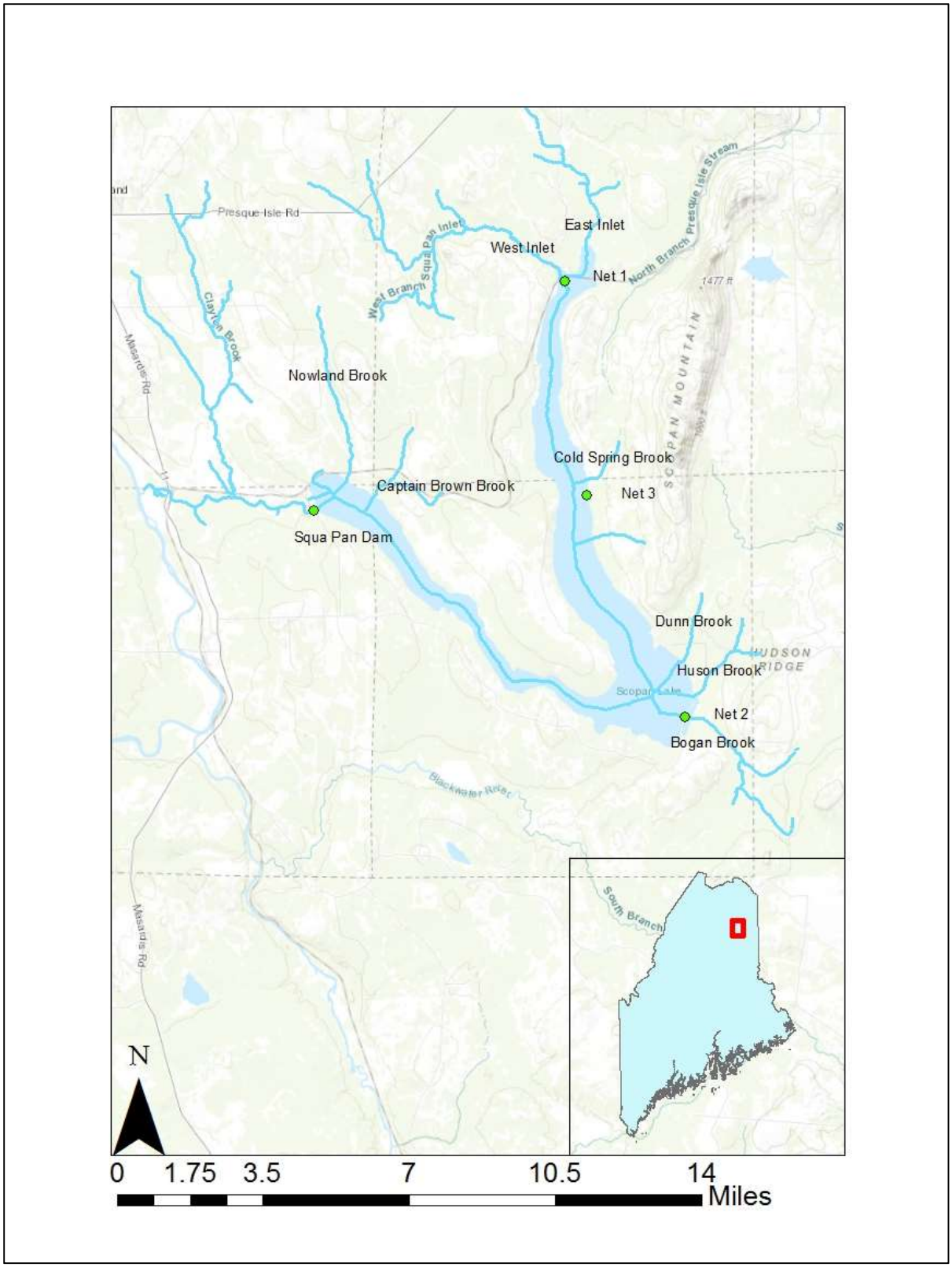

Figure 2. Stocking location and net locations in Scopan Lake. The lake was stocked on October 5th with 250 BKT (radio-tagged, N=10) and on October 23rd with 200 LLS (radio-tagged, N=5).

Fish Tracking

Fish tracking occurred on 16 separate occasions with varying levels of effort, location coverage, and tracking methods, mostly dependent on weather conditions. Fish were tracked primarily by boat and twice on foot when weather conditions did not allow for safe boating. Tracking began on October 12th and continued until November 12th. After November 12th, ice formation on the lake prevented further tracking. One final tracking event occurred on December 16th to confirm that BKT #820 was dead.

The signal detection strength of the radio telemetry equipment is dependent on the depth of the fish, and fish were typically detected within 100-200 yards of their actual location. Because of the large size of the lake and the limitations of the radio-telemetry signal detection, some areas were tracked more thoroughly than others. The area of the lake between West Inlet and Big Cove was tracked more thoroughly than the area of the lake closest to the dam. The middle of the Big Cove area was not tracked as thoroughly because of its large size, though on several occasions effort was made to track in this area more extensively. Another area that was not covered thoroughly was the East Inlet. It was inaccessible by boat and by foot, and it is possible that fish could have moved there post-stocking due to its proximity to the stocking location. Effort was made on several occasions to track in areas that were less accessible or were less thoroughly covered, but it is possible, though unlikely, that certain fish were not found in areas that were not tracked as frequently.

RESULTS

Fish Sampling

The fish community at Scopan Lake, as sampled by trapnet, was dominated by brown bullhead, yellow perch, white sucker, redbreast sunfish, and golden shiner (*Notemigonus crysoleucas*; GLS) (Figure 3). Immediately after stocking 250 FY brook trout on October 5th, several hatchery trout were captured in each net and were identified by degree of fin erosion. Only one wild brook trout (total length: 7.6 in, weight: 1.8 oz) was captured throughout the entire sampling period. Additionally, one spring yearling hatchery landlocked salmon was captured at net 2 at Cold Spring Brook.

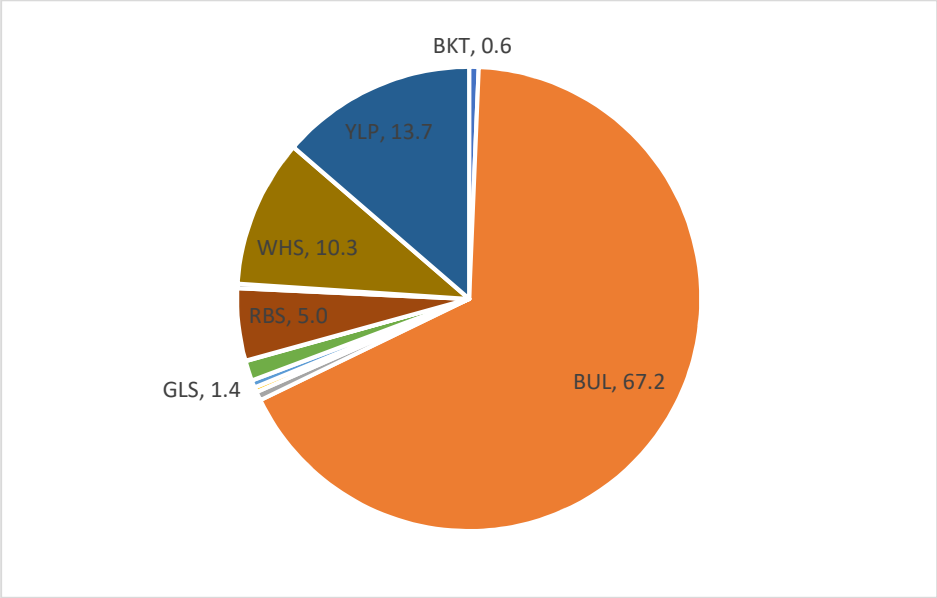

Figure 3. Percentage of total catch by number of each fish species at all trapnet locations in Scopan Lake. Additional species captured include common shiner, fallfish, creek chub, splake, and landlocked salmon. All brook trout captured except for one were of hatchery origin.

Fish composition at all three sampling locations was dominated by brown bullhead, yellow perch, white sucker, and redbreast sunfish (Figure 4). The Bogan Brook site had an exceptionally high catch of brown bullhead, but otherwise fish composition was similar across all three sampling locations (Figure 4).

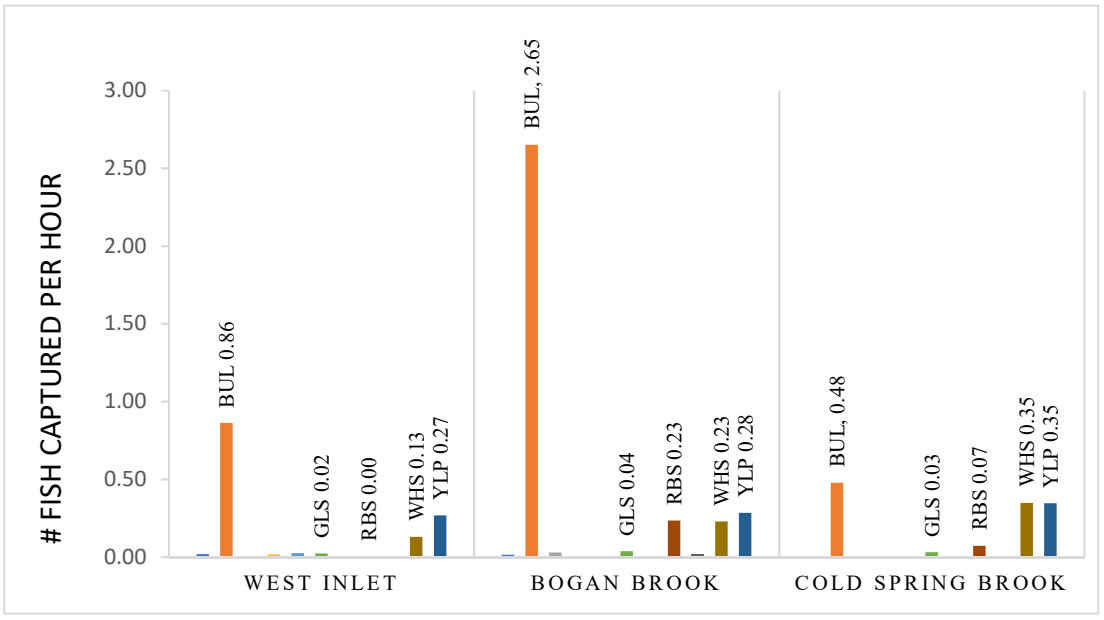

Figure 4. Catch rates per hour for each species at all trapnet locations in Scopan Lake. Additional species captured include common shiner, fallfish, creek chub, brook trout, splake, and landlocked salmon. All brook trout except for one were of hatchery origin.

Biomass (lb.) across all three sites was dominated by brown bullhead (52.5%), white sucker (21.1%), yellow perch (17.8%), redbreast sunfish (3.0%) and brook trout (3.1%; Figure 5; Appendix Table 1). All but one brook trout captured during the sampling period were FY hatchery brook trout that were stocked on October 5th.

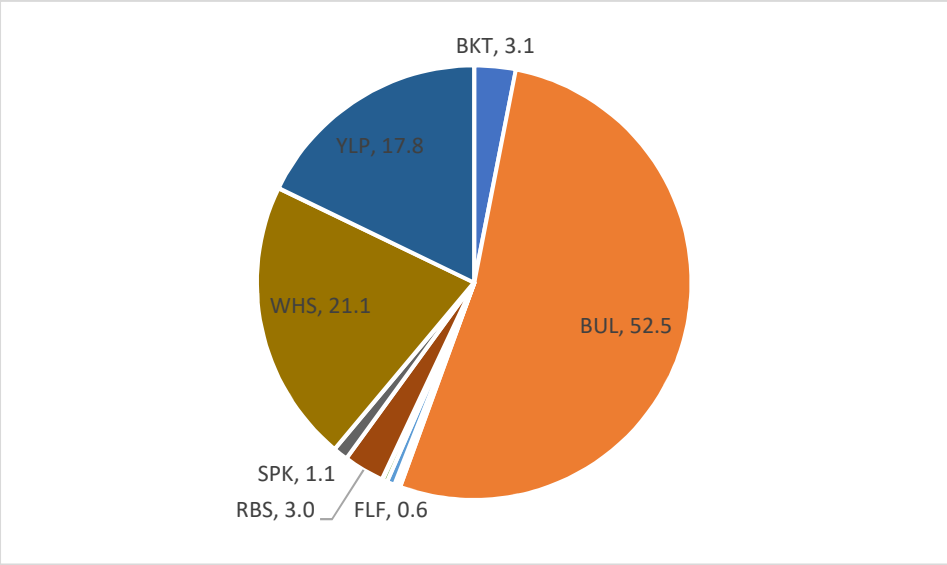

Figure 5. Percentage of total biomass (lb.) of each species captured at all trapnet locations in Scopan Lake. Additional species captured include golden shiner, common shiner, creek chub, splake, and landlocked salmon. All brook trout captured except for one were of hatchery origin.

Biomass at each site was dominated by brown bullhead, white sucker, yellow perch, and redbreast sunfish (Figure 6). Net 1 at West Inlet had the highest biomass of brook trout, because it was only 0.5 miles from the stocking location. Net 2 at Bogan Brook also had a considerably higher biomass of brown bullhead than nets 1 and 3.

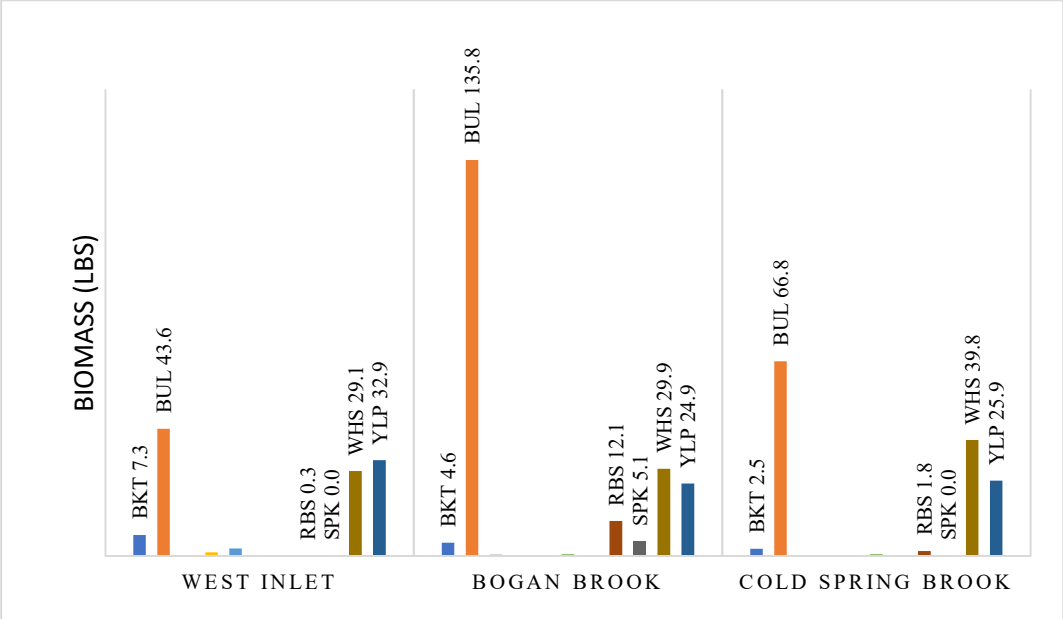

Figure 6. Total biomass (lb.) of each species at each trapnet location. Additional species captured include common shiner, golden shiner, brook trout, splake, creek chub, fallfish, and landlocked salmon. All brook trout captured except for one were of hatchery origin.

Fish Tracking

Survival - Fish tracking began on October 12th and continued until November 12th, when weather conditions and ice cover prevented further tracking. Tracking occurred on 16 separate occasions for a total of 110 fish observations in 109.1 hours of tracking time (Table 2). Within one month of stocking, five fish were confirmed dead (BKT #731, 810, 820, 840; LLS #742), three were never found and are presumed dead (BKT #720, 751, and 831), and three were found for the first two weeks but were not found after November 1st (BKT #711, 770, 801). Four landlocked salmon (LLS #701, 761, 781, and 791) were potentially still alive when tracking concluded on November 12th (Table 3). Discounting the splake (which had been alive in the lake for about 12 months since stocking in October 2017), it is possible that more than two-thirds (N=11) of the radio-tagged fish died within one month of stocking.

Table 2. Tracking events at Scopan Lake (also in map form in Appendix, Figures 1-16).

Date	Method	# Hours Tracking	# of Fish Located	Crew
10/12/2018	boat	4.5	2	A. Grant
10/17/2018	boat	6.5	2	A. Grant
10/18/2018	foot	6.75	2	A. Grant
10/19/2018	boat	9	8	A. Grant
10/22/2018	boat	8.5	7	A. Grant
10/23/2018	boat	9.5	9	A. Grant
10/27/2018	boat	7.25	9	A. Grant
10/29/2018	boat	7	13	A. Grant
10/30/2018	boat	7.25	12	A. Grant

11/1/2018	boat	8	12	A. Grant
11/5/2018	boat	6	7	A. Grant
11/5/2018	boat	4.33	3	F. Frost
11/6/2018	boat	7.5	12	A. Grant
11/8/2018	foot	6.5	5	A. Grant
11/9/2018	boat	6	5	A. Grant
11/12/2018	boat	4	1	A. Grant
12/16/2018	foot	0.5	1	A. Grant
Total		**109.1**	**110**	

Table 3. Status and number of observations of each tagged fish.

Species	Tag #	Status	Last Observed	# Observations
BKT	711	Unknown	10/30/2018	5
BKT	720	Unknown	Never	0
BKT	731	Dead	11/9/2018	12
BKT	751	Unknown	Never	0
BKT	770	Unknown	11/1/2018	5
BKT	801	Unknown	10/29/2018	5
BKT	810	Dead	11/9/2018	11
BKT	820	Dead	12/16/2018	12
BKT	831	Unknown	Never	0
BKT	840	Dead	11/9/2018	6
LLS	701	Alive	11/6/2018	6
LLS	742	Dead	11/9/2018	8
LLS	761	Alive	11/6/2018	6
LLS	781	Alive	11/6/2018	6
LLS	791	Alive	11/6/2018	5
SPK	532	Alive	11/6/2018	9
SPK	552	Alive	11/6/2018	8
SPK	672	Alive	11/6/2018	6
				110

Movement - Three fish (BKT #810; LLS #742, and LLS #791) were found in Captain Brown Brook on November 5th, presumably searching for spawning habitat (Figure 7, 9-11). However, BKT #810 and LLS #742 were both confirmed dead on November 9th, likely a result of predation, while LLS #791 left the brook and was found approximately 7.4 miles from Captain Brown Brook the next day on November 6th (Figure 8, 9). The tag for BKT #810 was recovered on the bottom of the brook approximately 1,000 ft upstream from the lake on November 9th (Figure 10), while the tag for LLS #742 was located close to tag #810, buried in a large pile of debris adjacent the brook; this LLS tag was not recovered (Figure 11). Additionally, BKT #711 was observed between Captain Brown Brook and Big Cove on October 30th, around the same time BKT #810,

LLS #742, and LLS #791 entered Captain Brown Brook, but was never found after this date. It is unknown whether this fish attempted to spawn or if it is still alive (Figure 12).

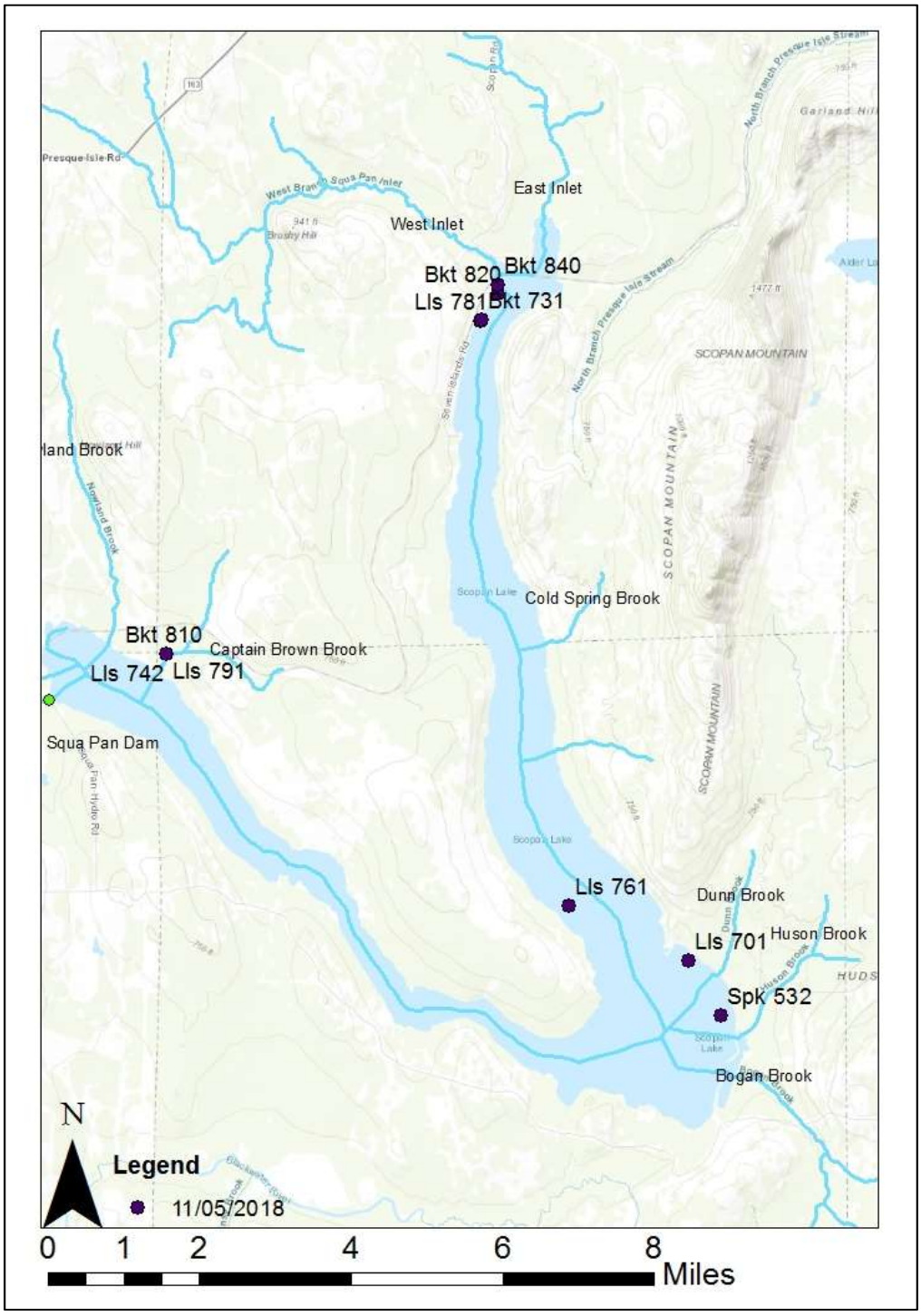

Figure 7. Fish locations for 10 fish found during a combined tracking time of 10.33 hours on November 5th. LLS #742, LLS #791, and BKT #810 were all found in the same location in Captain Brown Brook.

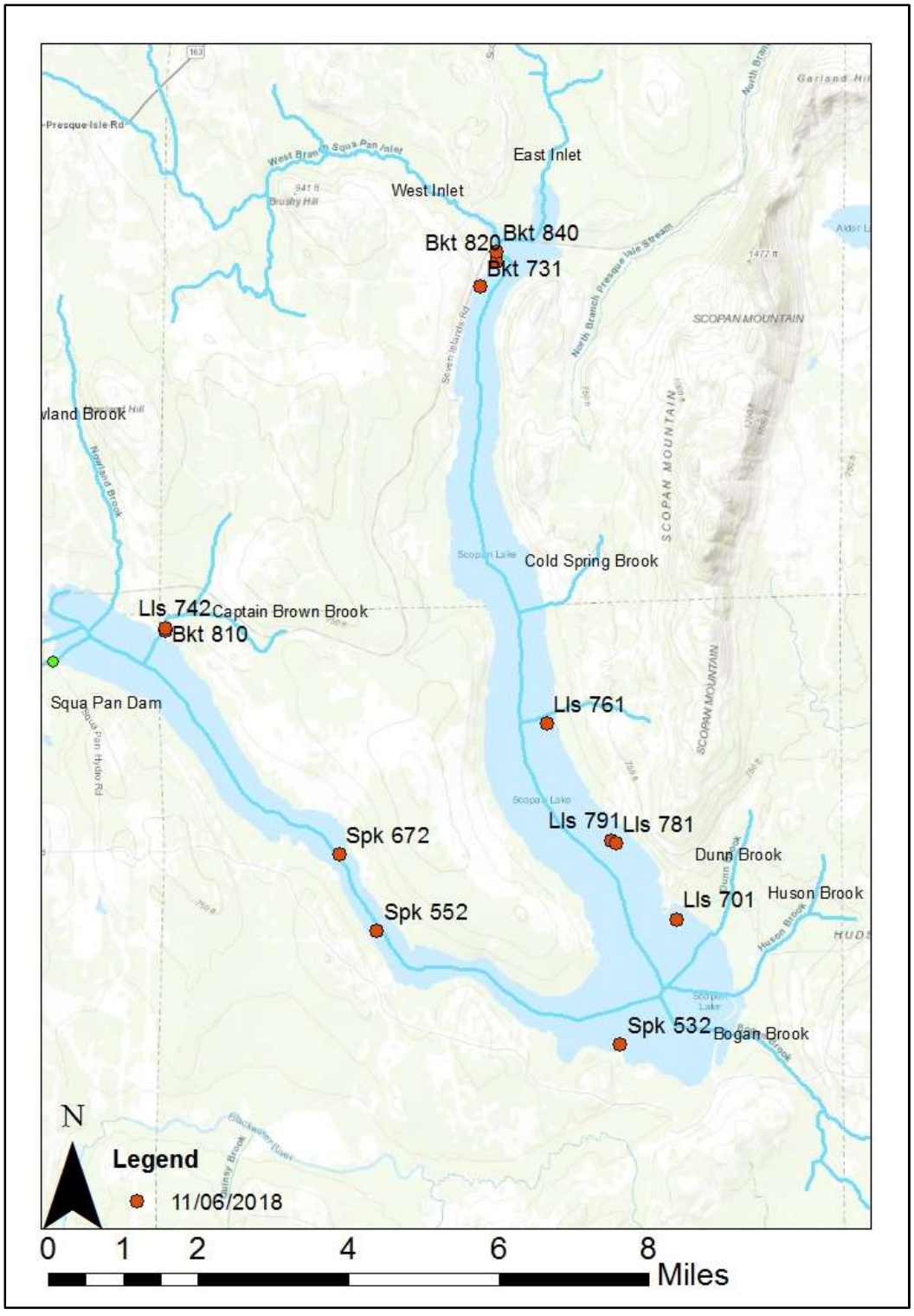

Figure 8. Fish locations for 12 fish found during a 7.5-hour tracking event on November 6th.

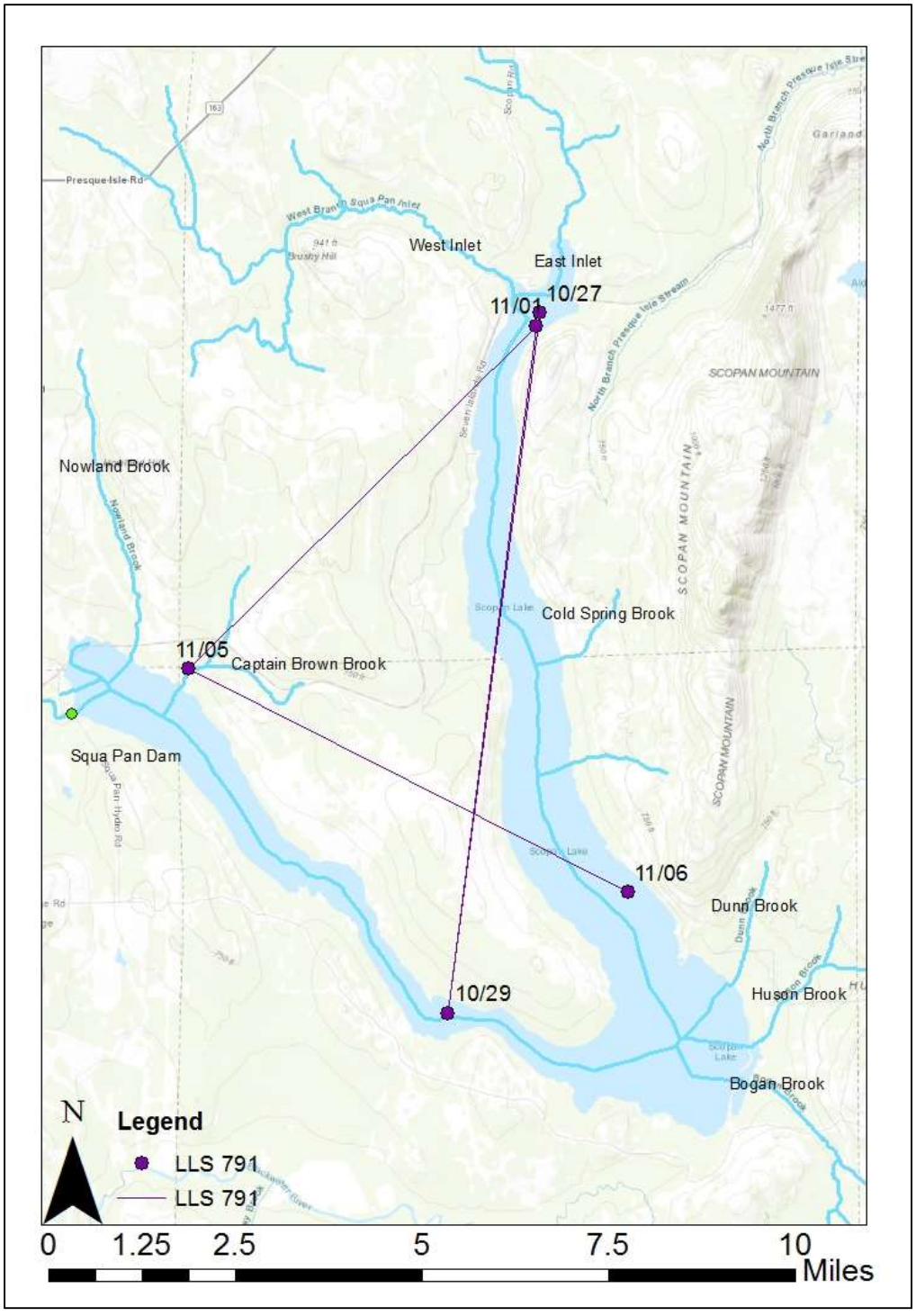

Figure 9. Locations for LLS #791 on five different dates (10/27-11/06). This fish entered Captain Brown Brook, along with BKT #810 and LLS #742 on November 5th. However, on November 6th, it was found 7.4 miles away, and the other two fish (BKT #810, LLS #742) were confirmed dead in Captain Brown Brook on November 9th.

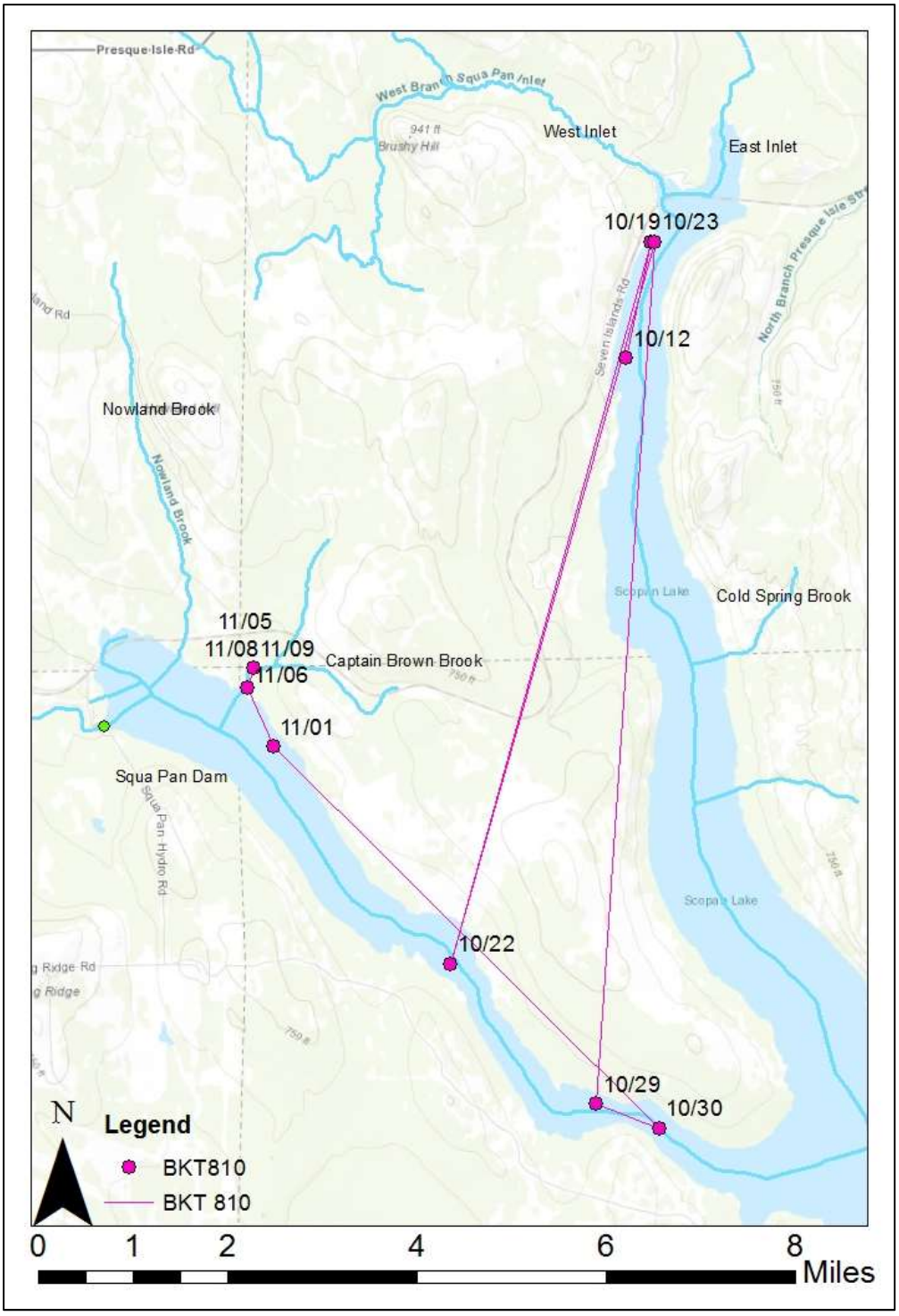

Figure 10. Locations for BKT #810 on 11 different dates (10/12-11/9). This fish was observed in Captain Brown Brook starting around November 1st, presumably staging to spawn, but was confirmed dead on November 9th when its tag was recovered.

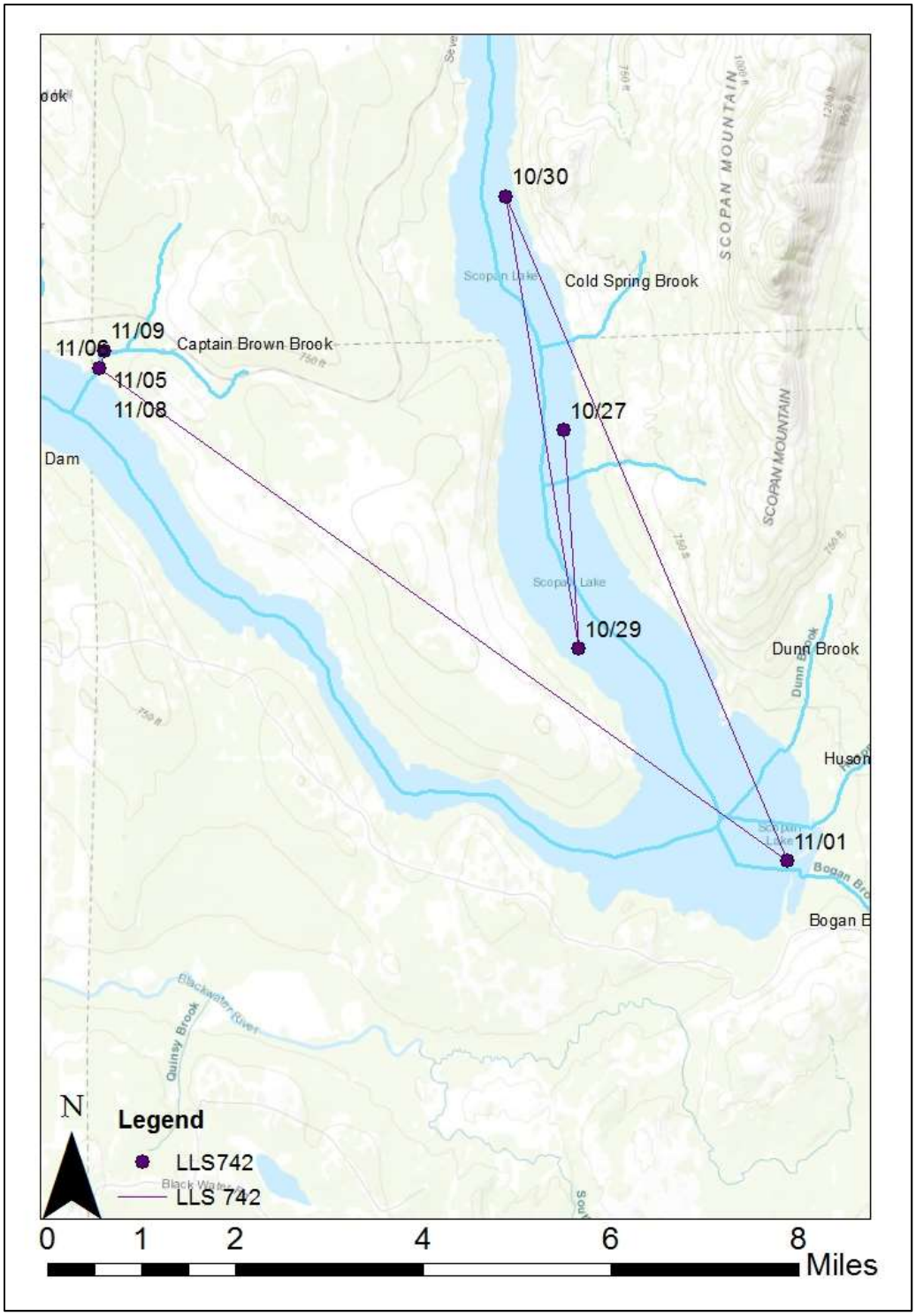

Figure 11. Locations for LLS #742 on eight different dates (10/27-11/9). This fish was confirmed dead on November 9th, and the tag was located in a debris pile next to Captain Brown Brook but was not recovered.

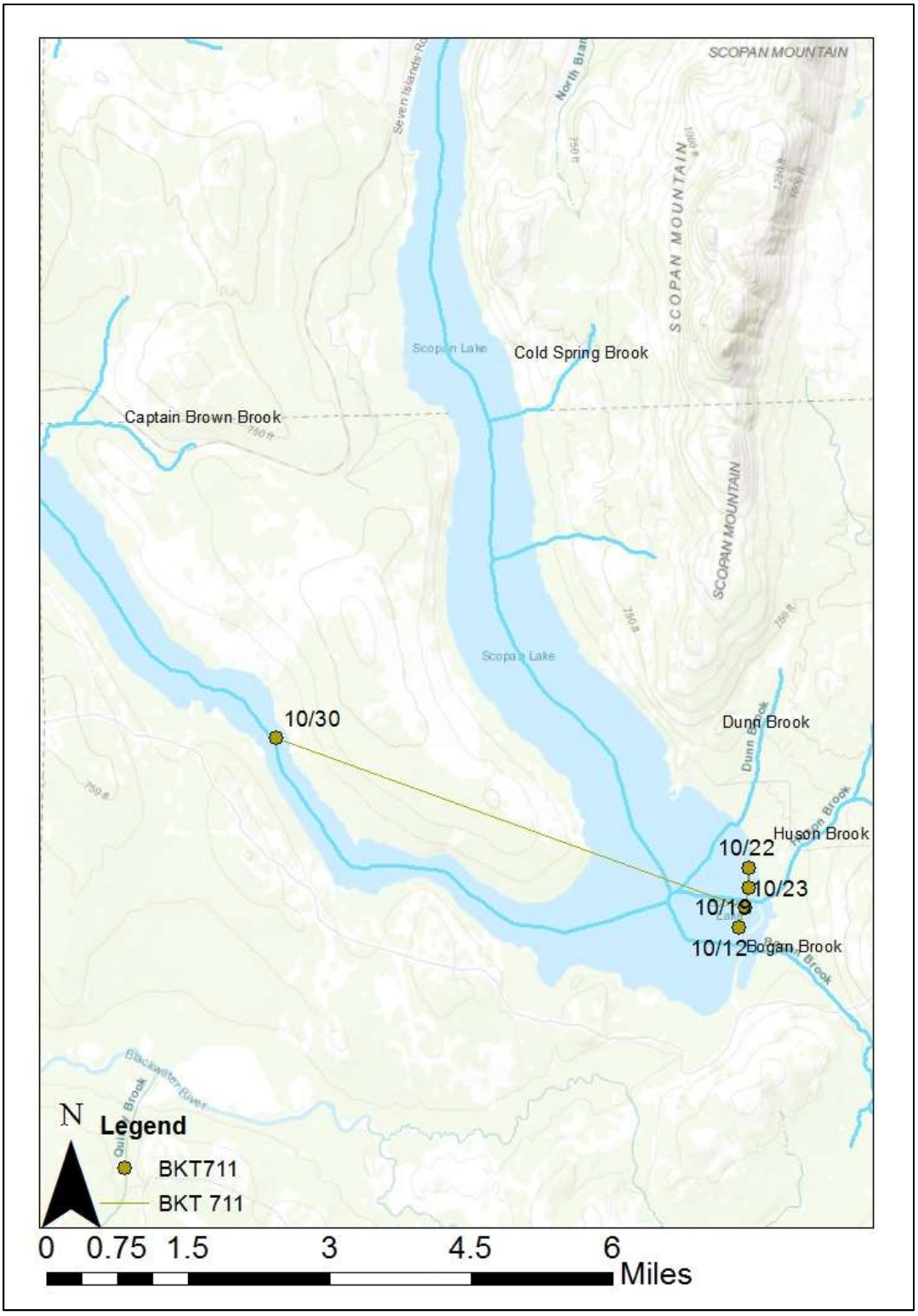

Figure 12. Locations for BKT #711 on five different dates (10/12-10/30).

Two female brook trout (BKT #731 and #840) and one male brook trout (BKT #820) were found in West Inlet in early November, presumably searching for spawning sites (Figure 7, 8). BKT #840 was found in West Inlet as early as October 18th and remained in West Inlet until November 9th when it was confirmed dead. The exact date that it died is unknown, but it is likely that it was dead prior to November 9th. The tag was found on November 8th and 9th in the exact same location adjacent to Inlet Road in a debris pile in shallow water, but the tag was not recovered (Figure 13). Brook trout #731 was also confirmed dead on November 9th, approximately 100 feet from BKT #840, suggesting that they were both removed by predators (Figure 14). Brook trout #820 was confirmed dead in West inlet on December 16th, when it was found in the same location in West Inlet as it had been a month earlier (Figure 15).

Brook trout #770 and BKT #801 were consistently observed near the stocking location at West Inlet until November 1st (Figure 16, 17). However, while BKT #731 and BKT #820 entered West Inlet, BKT #770 and BKT #801 were not located after November 1st and it is unknown whether they attempted to spawn or were removed by predators.

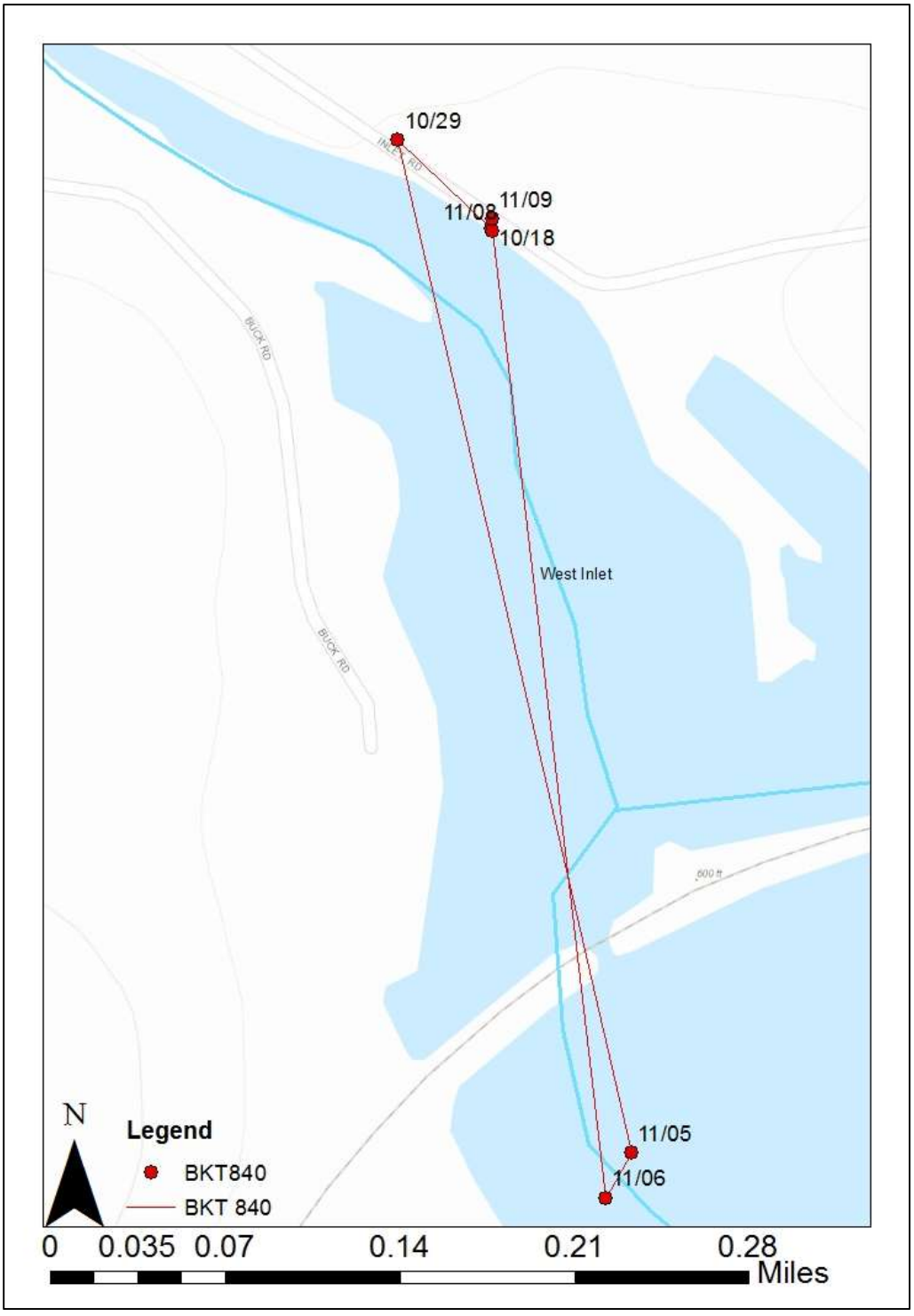

Figure 13. Locations for BKT #840 on six different dates (10/18-11/09). This fish was first located in West Inlet as early as October 18th and remained there until it was confirmed dead on November 9th.

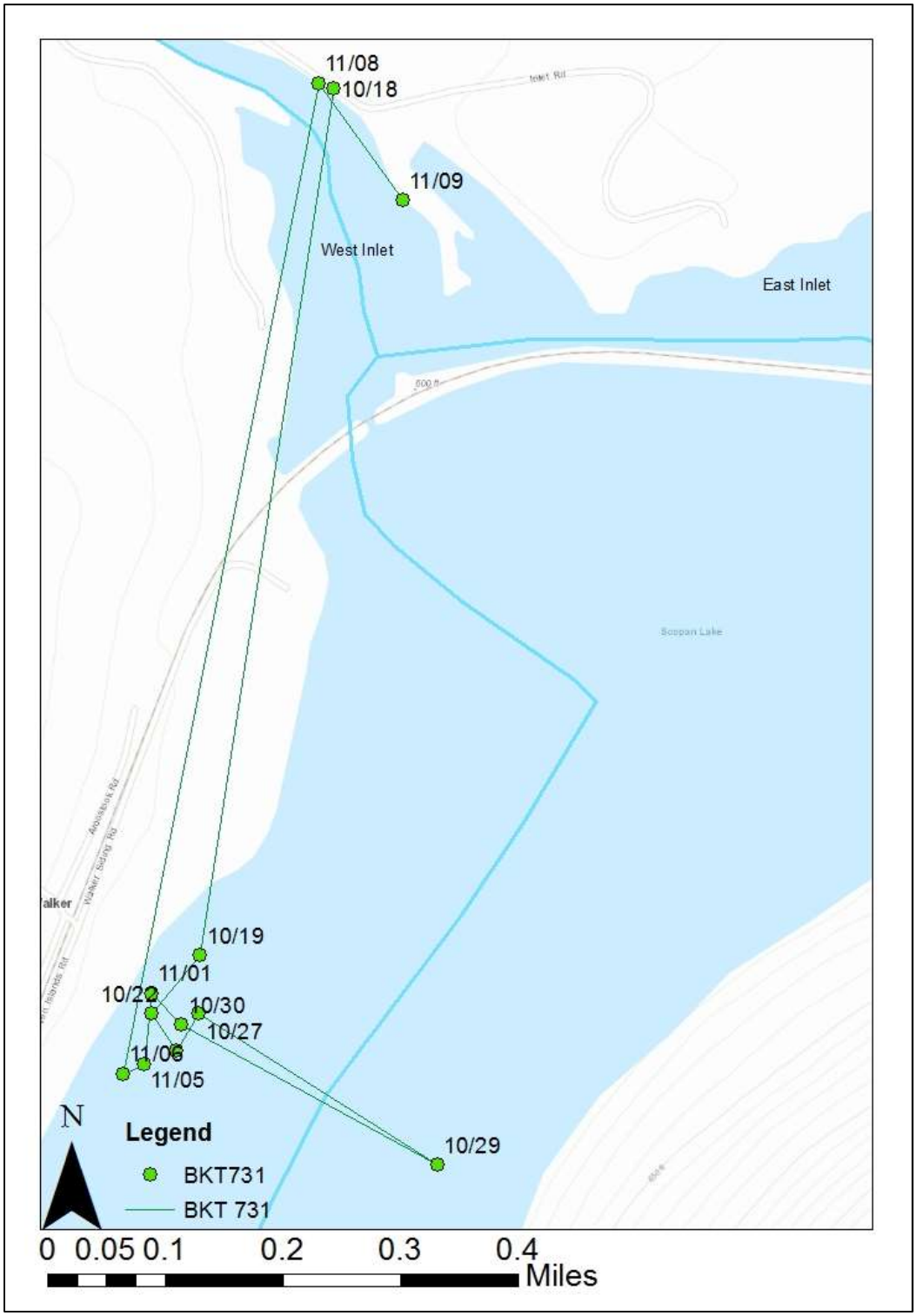

Figure 14. Locations for BKT #731 on 12 different dates (10/18-11/09). This fish was confirmed dead in West Inlet on November 9th, but the tag was not recovered.

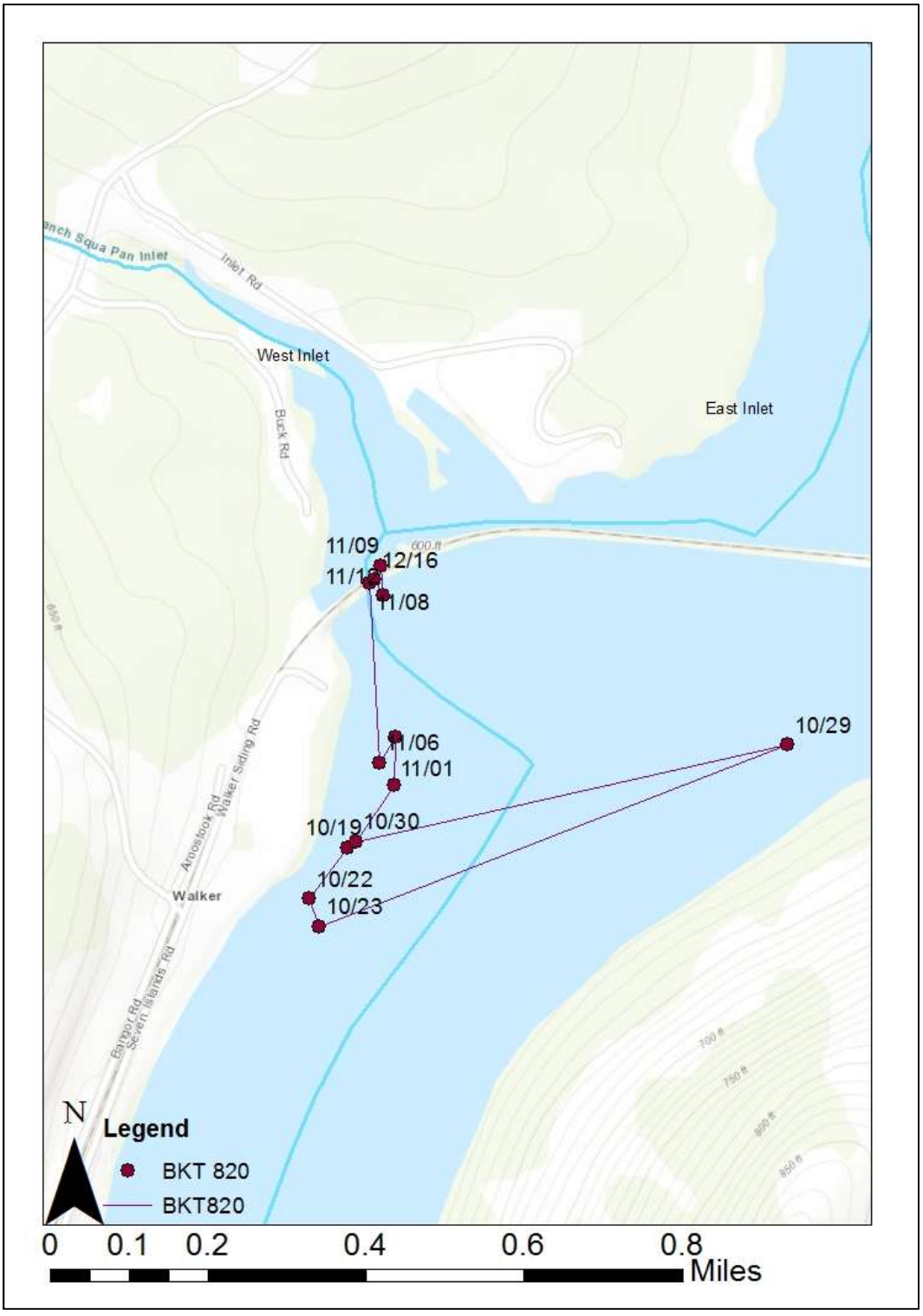

Figure 15. Locations for BKT #820 on 12 different dates (10/19-12/16). This fish was confirmed dead on December 16th, but the tag was not recovered.

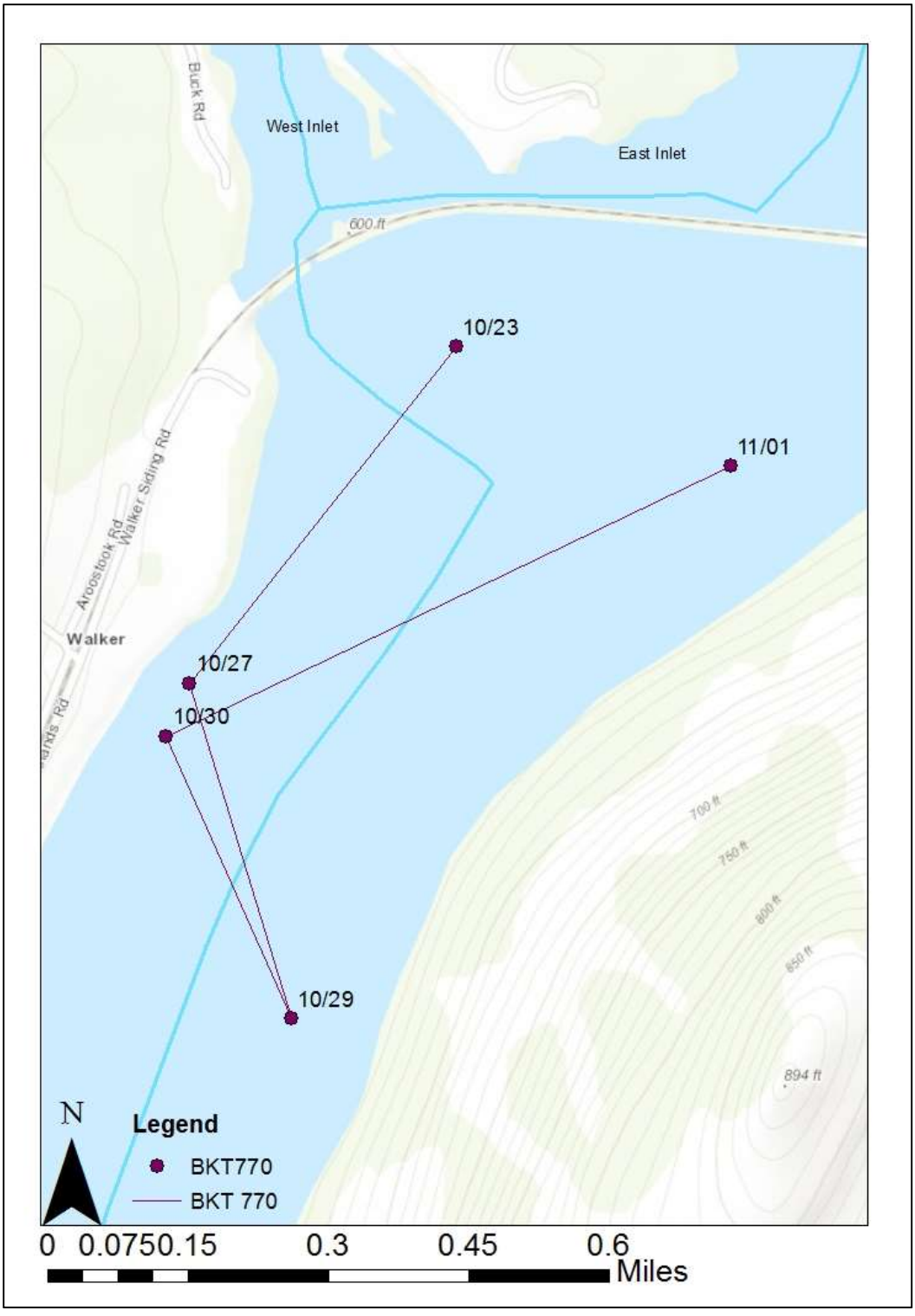

Figure 16. Locations for BKT #770 on five different dates (10/23-11/01). This fish was not found after November 1st and it is unknown whether it is still alive.

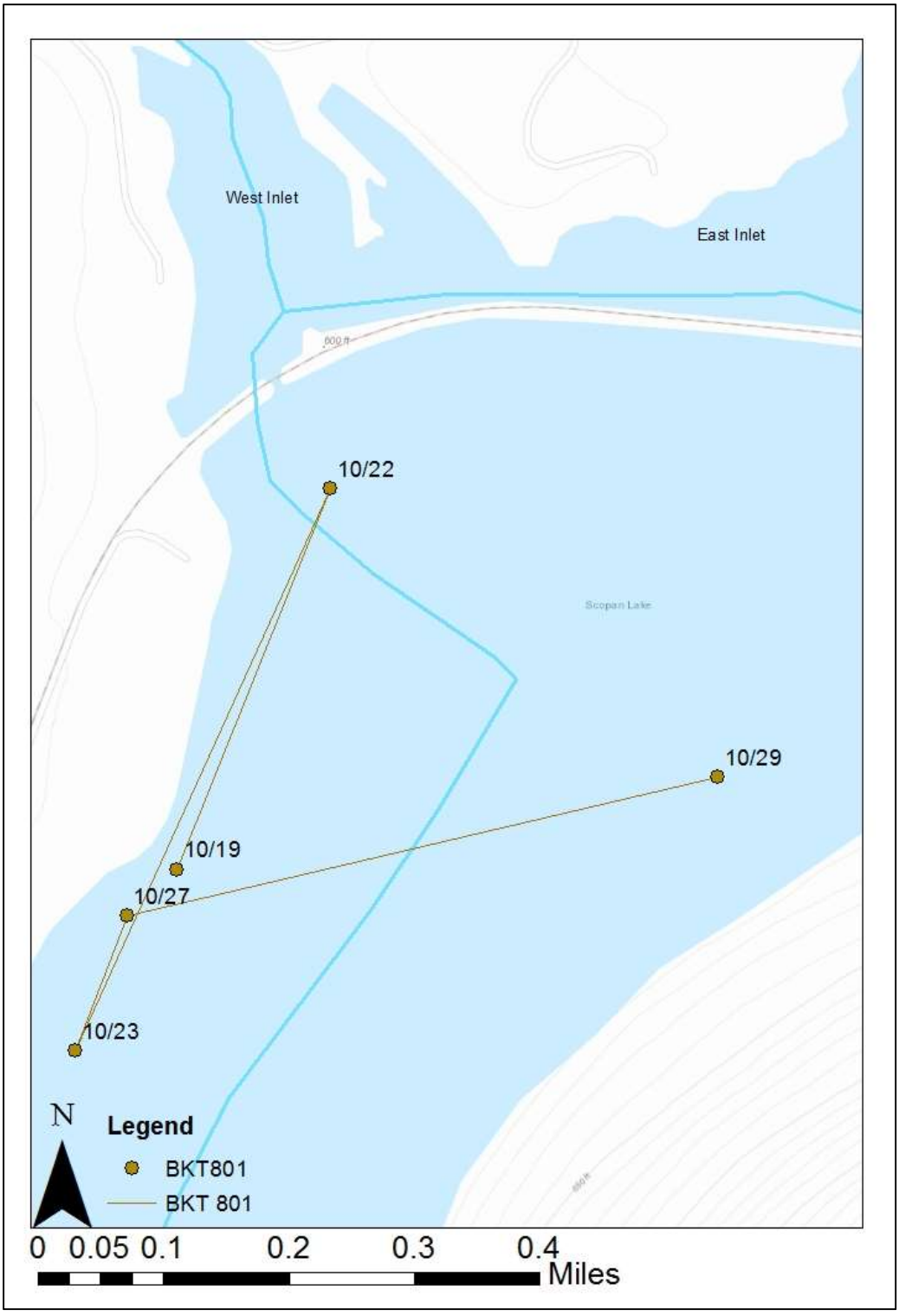

Figure 17. Locations for BKT #801 on five different dates (10/19-10/29). This fish was not found after October 29th and it is unknown whether it is alive.

Three landlocked salmon (LLS #701, 761, and 781) were found consistently from October 27th until November 6th but were not found making any attempt to spawn in the tributaries (Figures 18-20). All three fish were presumed to be alive at the termination of tracking on November 12th.

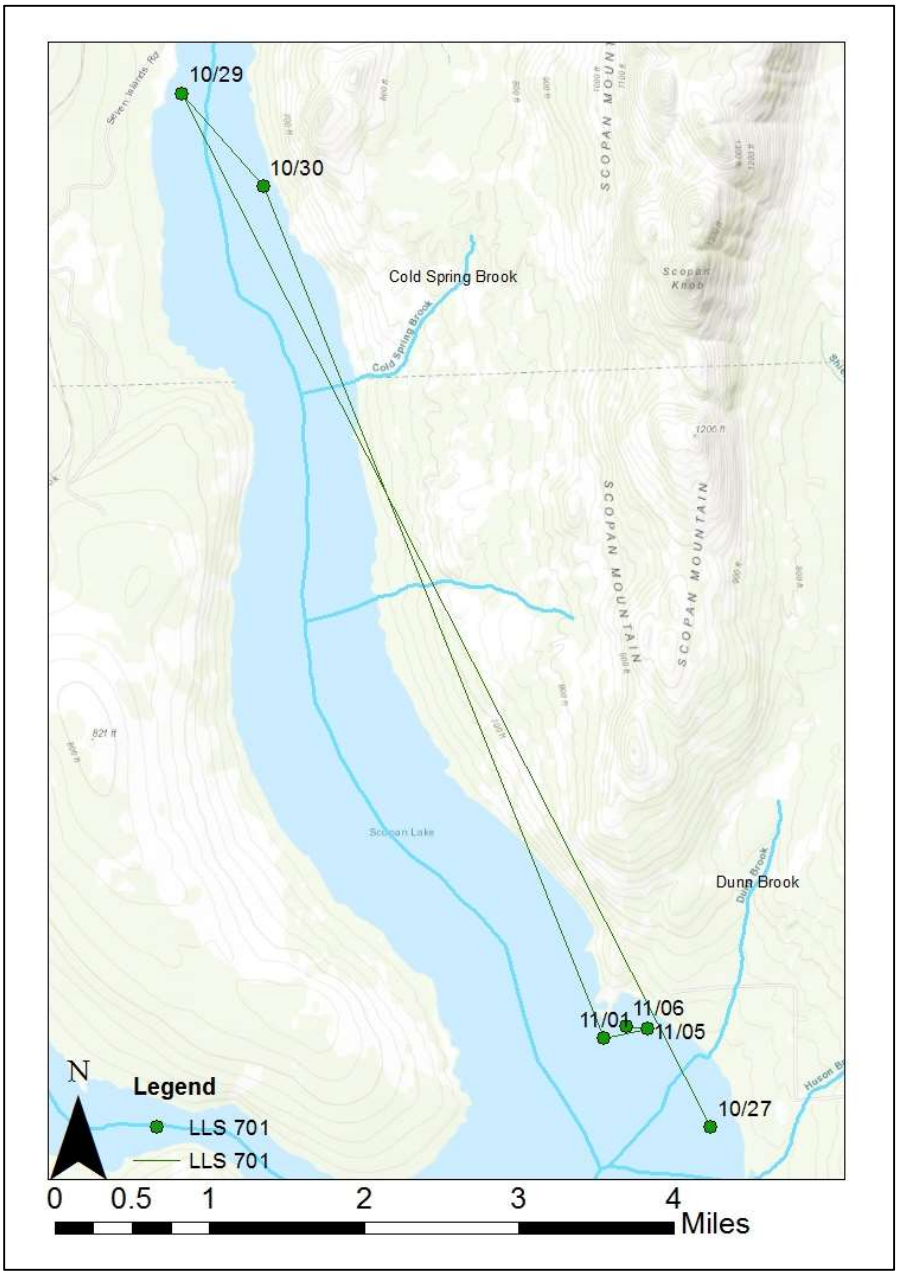

Figure 18. Locations for LLS #701 on six different dates (10/27-11/06).

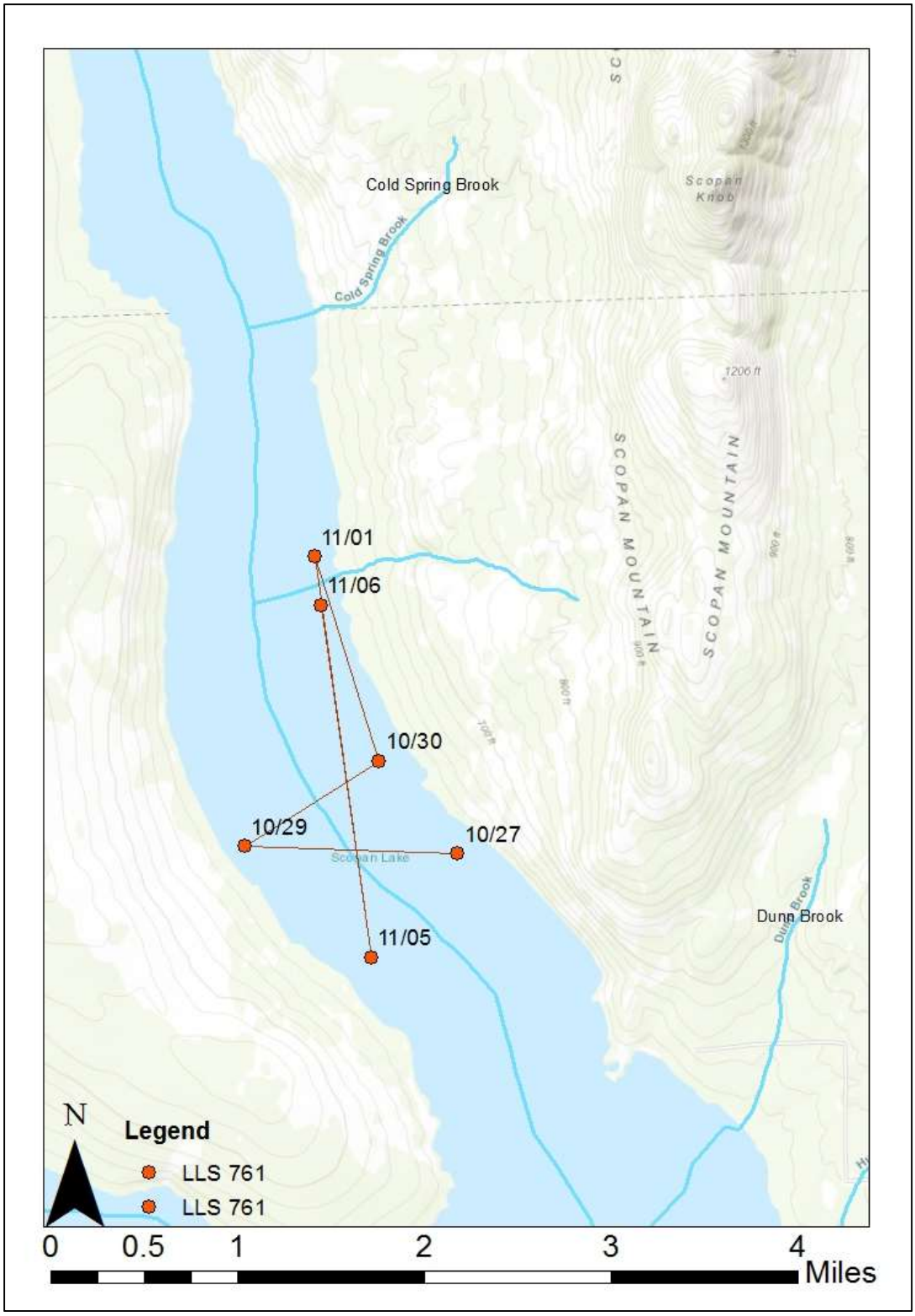

Figure 19. Locations for LLS #761 on six different dates (10/27-11/05).

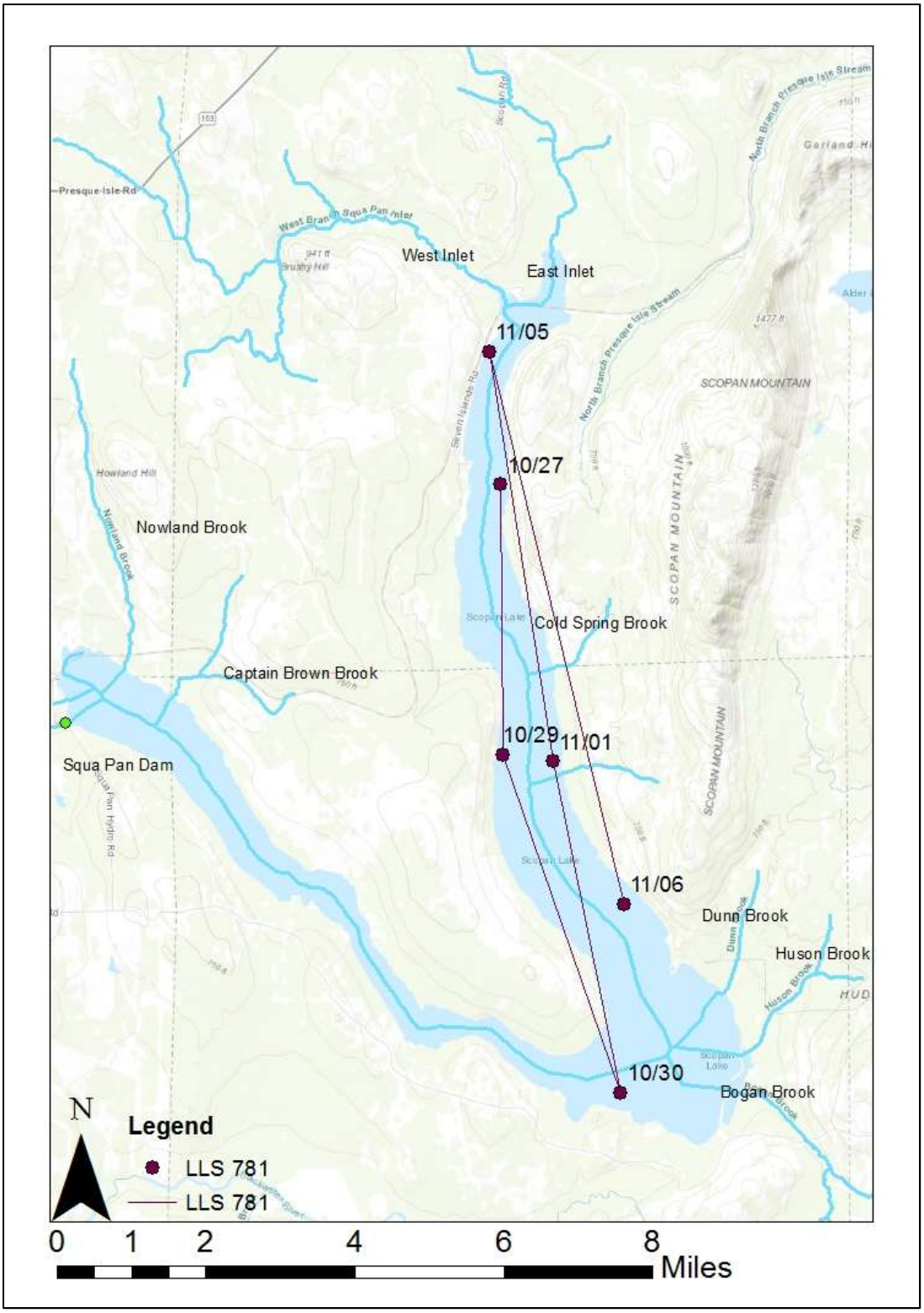

Figure 20. Locations for LLS #781 on six different dates (10/27-11/06).

Two of the three splake (SPK #552, 672) were consistently located between Bogan Brook and the dam (Figure 21-22), while the third (SPK #532) was consistently located between Bogan Brook and West Inlet (Figure 23).

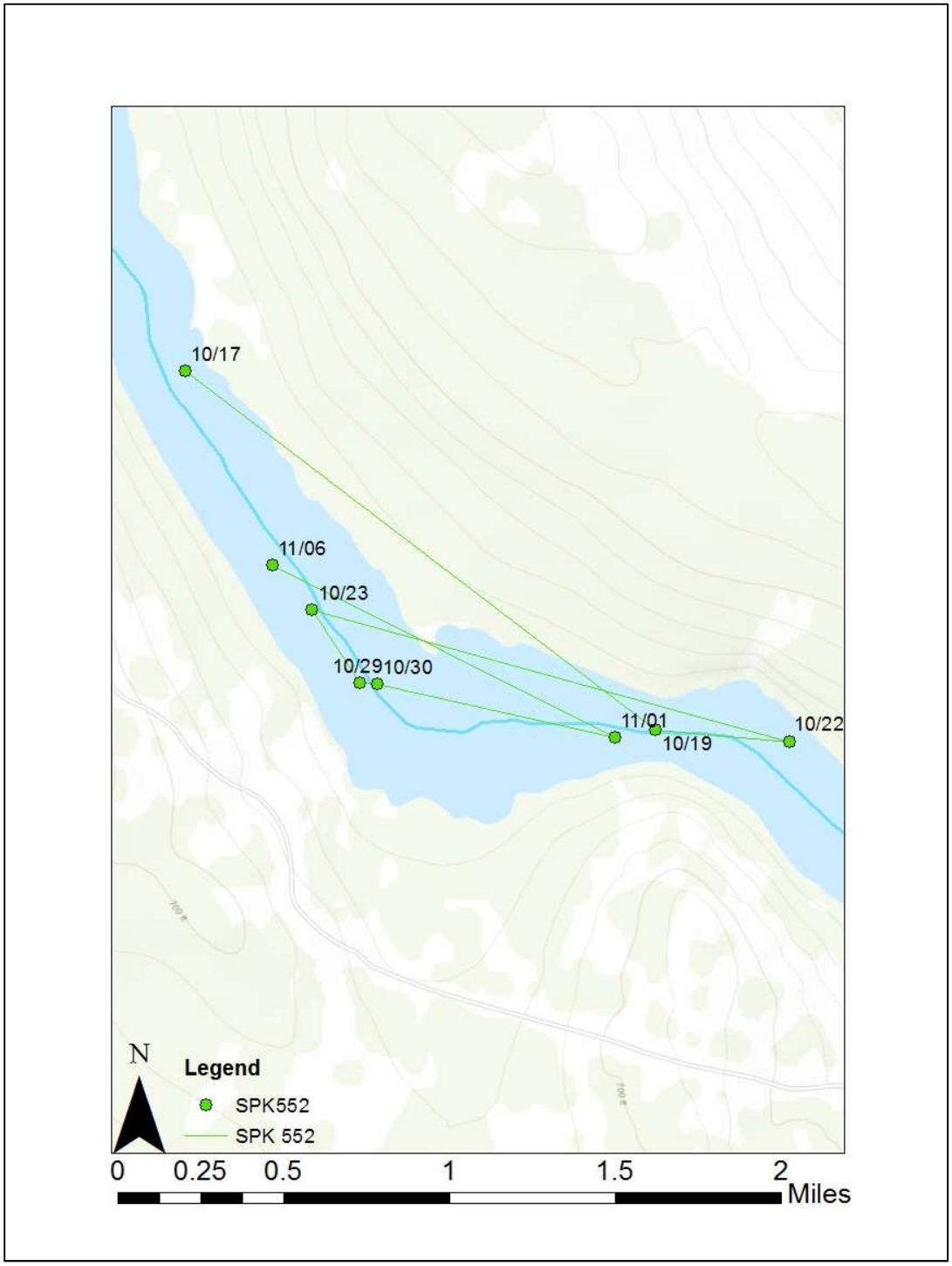

Figure 21. Locations for SPK #552 on eight different dates (10/17-11/06).

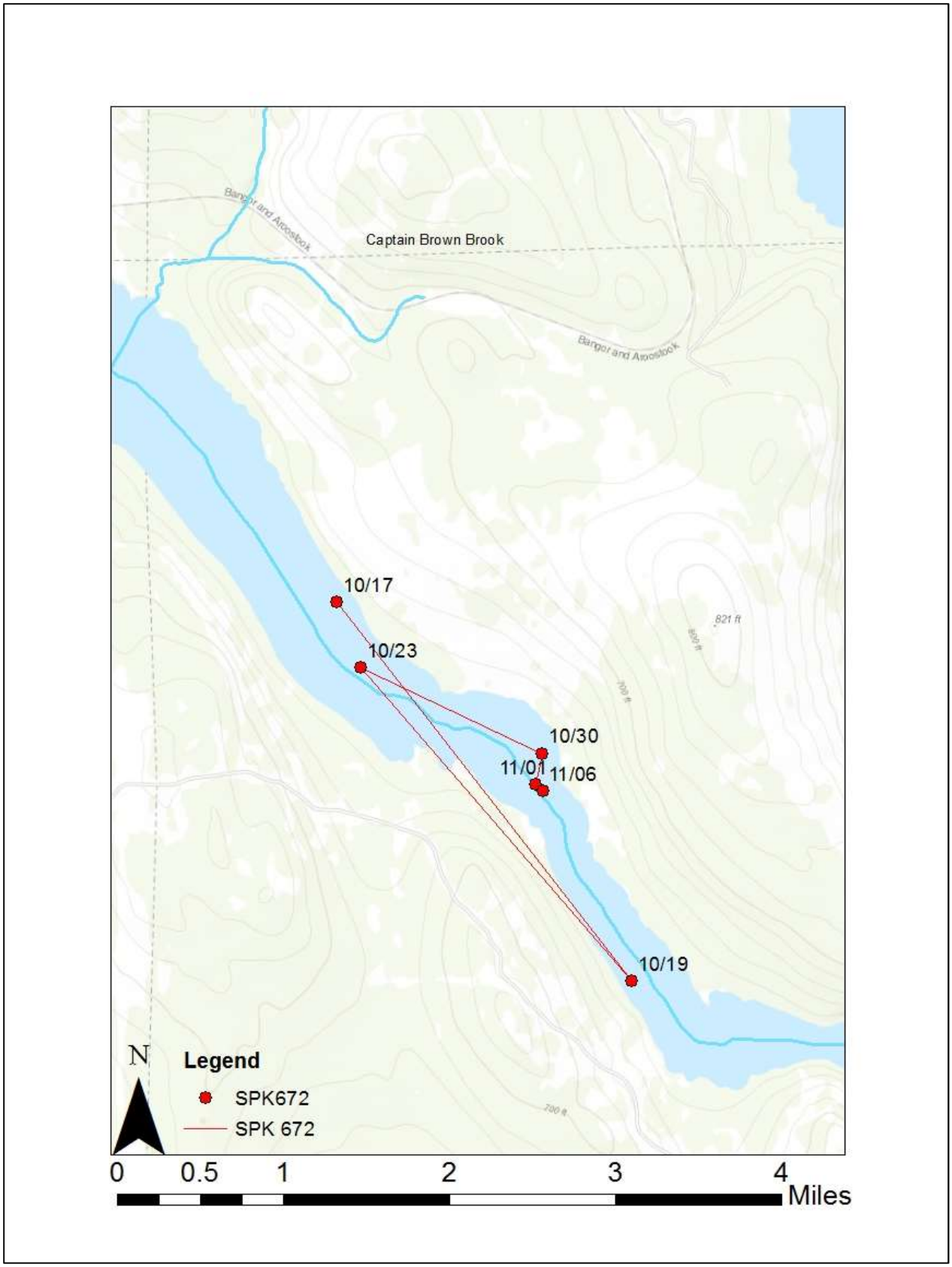

Figure 22. Locations for SPK #672 on six different dates (10/17-11/06).

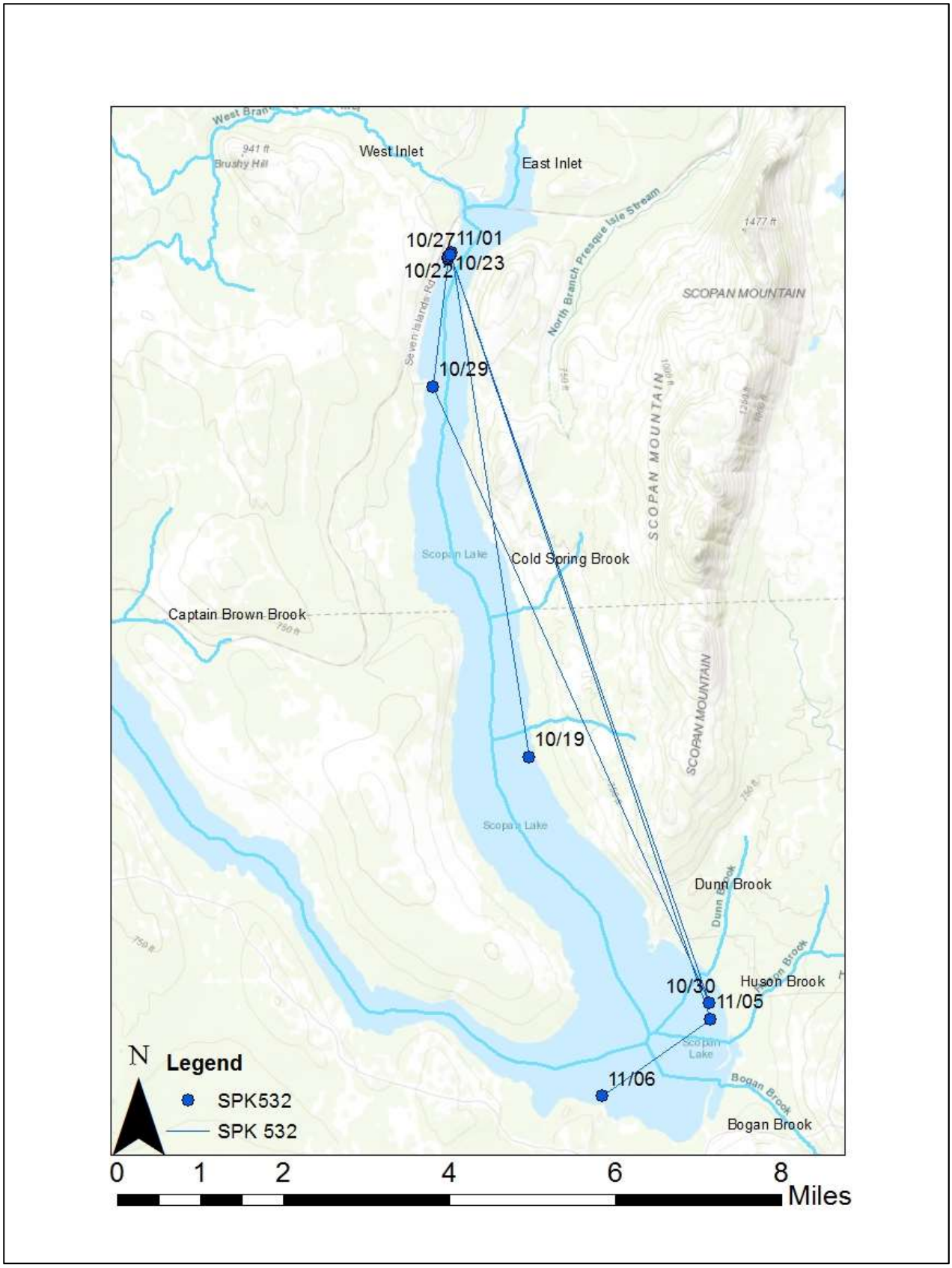

Figure 23. Locations for SPK #532 on nine different dates (10/19-11/05).

At the end of tracking, no brook trout could be confirmed alive. Four brook trout were confirmed dead (BKT #731, 810, 820, and 840), and three were not located after November 1st (BKT #711, 770, and 801). Three male brook trout (BKT #720, 751, and 831) were never located following stocking and were presumed to be dead. One landlocked salmon (LLS #742) was confirmed dead, and the remaining four landlocked salmon are likely still alive. All three splake were still alive, though they had been living in the lake for at least 11 months when they were tagged.

DISCUSSION

Scopan Lake has long been managed for salmonid sport fishing using cultured fish from State of Maine fish hatcheries. As early as 1950, it was clear that wild brook trout and landlocked salmon were at such low numbers that annual stocking would be necessary to provide fishing opportunity. Those early stocking programs continued and for decades now, the State of Maine through its IF&W Department, has attempted numerous stocking programs. The most successful one to date is the current fall yearling program for splake, a hybrid between brook and lake trout. Splake are stocked annually, providing a good winter fishery and some open-water fishing typically until early July each year. After this time, surface water warms to a point where cold-water fish are difficult to catch. Relatively few stocked fish survive, or "carry-over" through the ensuing few months of warm summer weather, as evidenced in our study where only three older splake were caught in trapnets. However, the lake is restocked again in late September when lake water temperatures cool, ensuring that there are fish to catch in the upcoming winter season.

Scopan Lake is, by far, the largest body of water in the southeastern portion of the Aroostook River watershed. The lake is a prominent water body on the landscape here and is a major draw for recreation, including sport fishing. Why other large lakes in the region with similar habitat have viable fisheries for wild trout and salmon while Scopan Lake does not remains a mystery. Cross Lake and Portage Lake (Fish River watershed), Millimagassett Lake (Aroostook River watershed), and Churchill Lake (Allagash River watershed) all have viable wild brook trout fisheries yet are relatively shallow (except Millimagassett) with large populations of competing fishes like Scopan Lake. Biologists have long cited habitat limitations at Scopan as justification for stocking programs, yet other lakes in the region with similar features do not need hatchery programs to provide sport fishing.

Large populations of competing species and marginal water quality do not fully explain why Scopan does not support appreciable numbers of wild trout and salmon. In this study, one aspect of hydropower operation – winter drawdown – was examined as to how it might be impacting reproductive success of trout and salmon. It was hypothesized that the extent of annual winter drawdowns, approximately 10 feet, was dewatering spawning redds, thereby reducing survival of embryos and recruitment of young fish. In the absence of wild trout and salmon, it was necessary to use hatchery fish for this study. In early October, hatchery trout and salmon were available. Most of the 450 FY fish were large and sexually mature, making them ideal surrogates for wild fish. Per hatchery staff, the fish were expected to search out

spawning sites soon after stocking. The locations of some fish suggest they do search out spawning sites and that some of these sites are well upstream of typical winter drawdown effects. Two tags in Captain Brown Brook were found 1,000 feet upstream of the lake. However, earlier-than-normal ice cover and the poor survival of the stocked fish limited any useful information to address our main objective. With such poor survival and difficult tracking conditions in this study, it was impossible to fully examine the effect of winter drawdown. Based on our results, radio telemetry will not be feasible to achieve the objective due to cost-prohibitive sample sizes.

Very low numbers of wild trout and salmon in Scopan Lake were documented in this study, corroborating results of multiple IF&W winter creel surveys conducted over the past 30 years. Three trapnets set for 22 days under optimum water temperatures and in likely areas where salmonids would be staging to spawn, caught no fish suitable to implant radio tags. Only one wild brook trout was captured during the 22-day sampling period. The trapnet catches were dominated by warm water non-sport fishes such as brown bullhead, yellow perch, and white sucker. It remains evident that the wild populations are too small to support self-sustaining fisheries and that continued stocking of hatchery fish is necessary.

The most recent hatchery program by the State of Maine is for splake, which was first established in 1990. Starting as a spring yearling (SY) program (8-10 in, stocked in May annually) it has been modified to stocking larger (typically 12–14 in) yearling fish in the fall. Most of the splake stocked in the fall are caught during the winter fishery; however, there are some "carry-over" splake that add size quality to angler catches during the following year (IF&W, unpublished data). Splake have water quality requirements intermediate to their two parent species, so it's surprising that splake do carry-over at Scopan given the water quality limitations that have long been cited as precluding a wild trout population. Splake may avoid tributary use in the fall, where they might be preyed upon more readily, explaining why historic brook trout stocking programs have failed. The level of predation on recently stocked FY trout documented in this study was surprising and occurred in or near tributaries. Five mortalities in such close proximity to one another in West Inlet and Captain Brown Brook indicate trout and salmon were likely preyed upon by otter (*Lontra canadensis*) and mink (*Neovison vison*). Mink were sited at West Inlet and Captain Brown Brook during multiple tracking events. Bald eagle (*Haliaeetus leucocephalus*) are also common in the area and one was sited at the mouth of Captain Brown Brook during the November 5th tracking event. Several other tags were never located by tracking, indicating these fish may have been removed from the system. Based on these results, such large hatchery fish entering relatively small tributaries to spawn are at very high risk of predation.

RECOMMENDATIONS

It is difficult to draw conclusions about the effects of lake drawdowns on wild salmonid reproduction in Scopan Lake from the results of this study. The lack of wild fish captures in trapnets confirms that wild trout and salmon populations are extremely low or non-existent in Scopan Lake. However, without being able to track wild fish and determine their spawning locations, it is impossible to determine how the winter lake drawdown is affecting spawning success. The results of fish tracking in Scopan Lake indicated that a high percentage of the

tagged fish died within one month after being tagged and stocked, likely a result of predation. The impact of the winter drawdown on salmonid reproduction in Scopan Lake cannot be definitively determined based on the results of this study, and other studies should be considered to help explain why Scopan Lake does not support wild trout and salmon while other regional lakes do. Despite the large expense, the current splake stocking program in Scopan Lake should be continued until issues precluding wild trout and salmon populations can be identified and resolved. Based on post-stocking survival of brook trout in this study, the use of hatchery brook trout may not be a cost-effective means of providing sport fishing.

APPENDIX

Table 1. Mean total length (in), mean weight (oz), and biomass (lb.) +/- S.D. for each species at all three trap net locations.

Species	Mean of T.L. (in)	Mean of Weight (oz)	Biomass (lb.)
BKT	12.5 (+/- 1.6)	15.4 (+/- 8.2)	14.4
BUL	7.4 (+/- 2.7)	2.5 (+/- 2.0)	246.2
CMS	5.3 (+/- 0.8)	0.8 (+/- 0.4)	0.7
CRC	8.2 (+/-1.5)	2.8 (+/- 1.0)	1.4
FLF	8.6 (+/- 2.3)	3.7 (+/-2.3)	2.7
GLS	5.4 (+/- 0.9)	0.9 (+/- 0.5)	1.7
LLS	9.5 (+/- 0)	3.2 (+/- 0)	0.2
RBS	5.8 (+/- 5.0)	2.0 (+/- 1.0)	14.2
SPK	16.3 (+/- 3.2)	20.5 (+/- 14.9)	5.1
WHS	9.9 (+/- 3.0)	6.7 (+/- 4.1)	98.9
YLP	8.3 (+/- 1.6)	4.2 (+/- 2.8)	83.7
Total			**469.3**

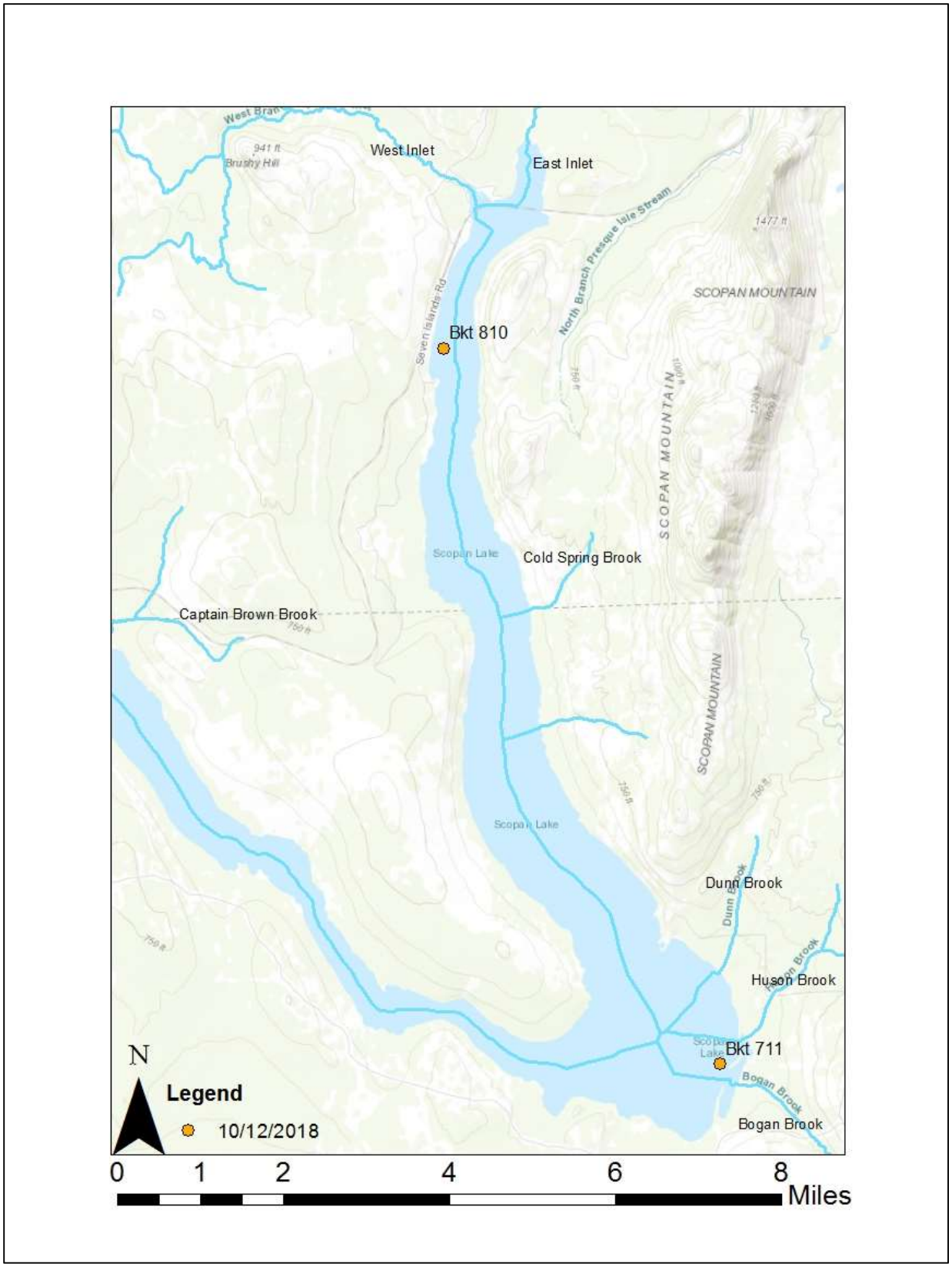

Figure 1. Tracking location for BKT #711 and #810 found during a 4.5-hour tracking event on October 12th.

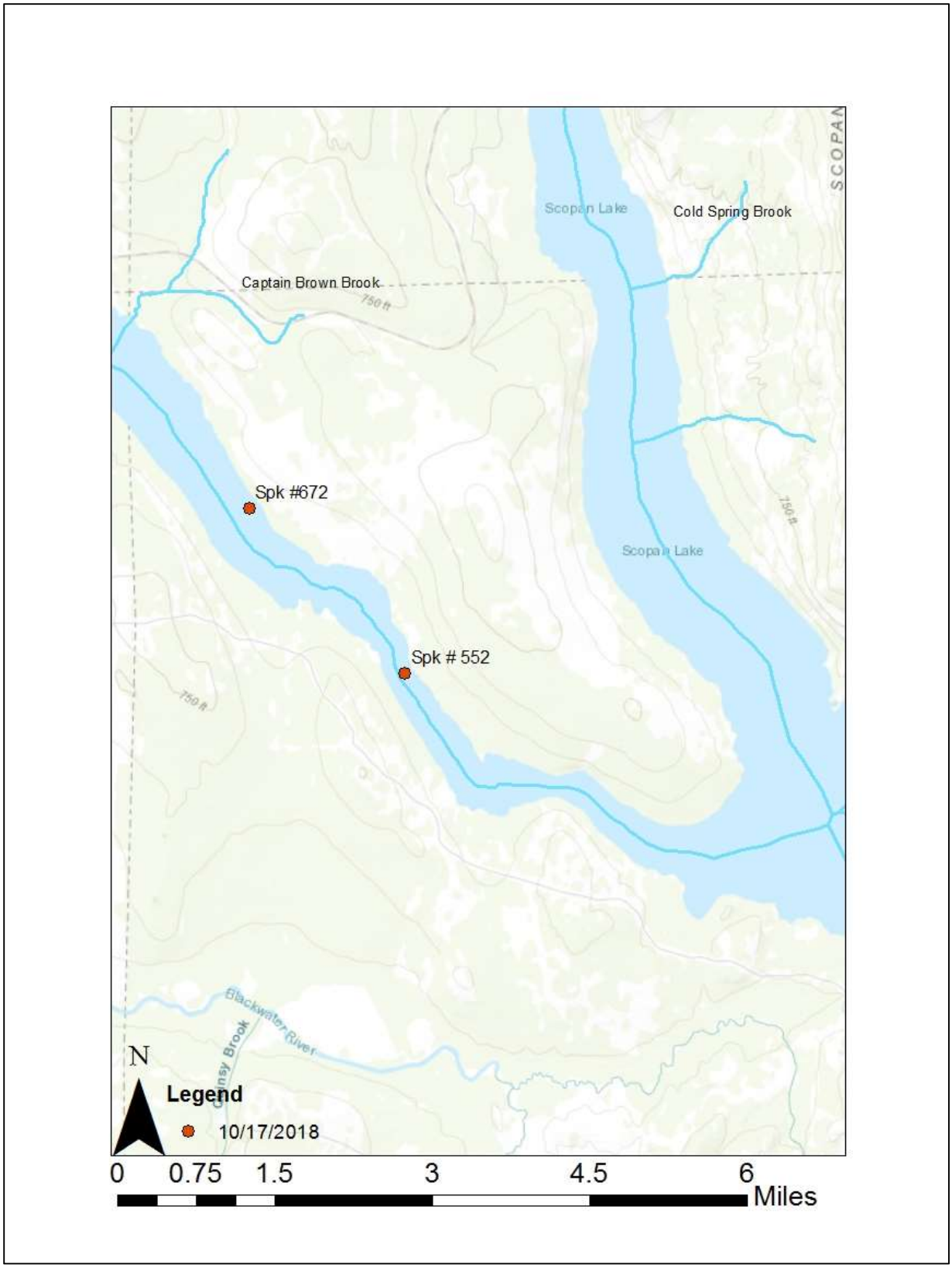

Figure 2. Tracking location for SPK #552 and #672 found during a 6.5-hour tracking event on October 17th.

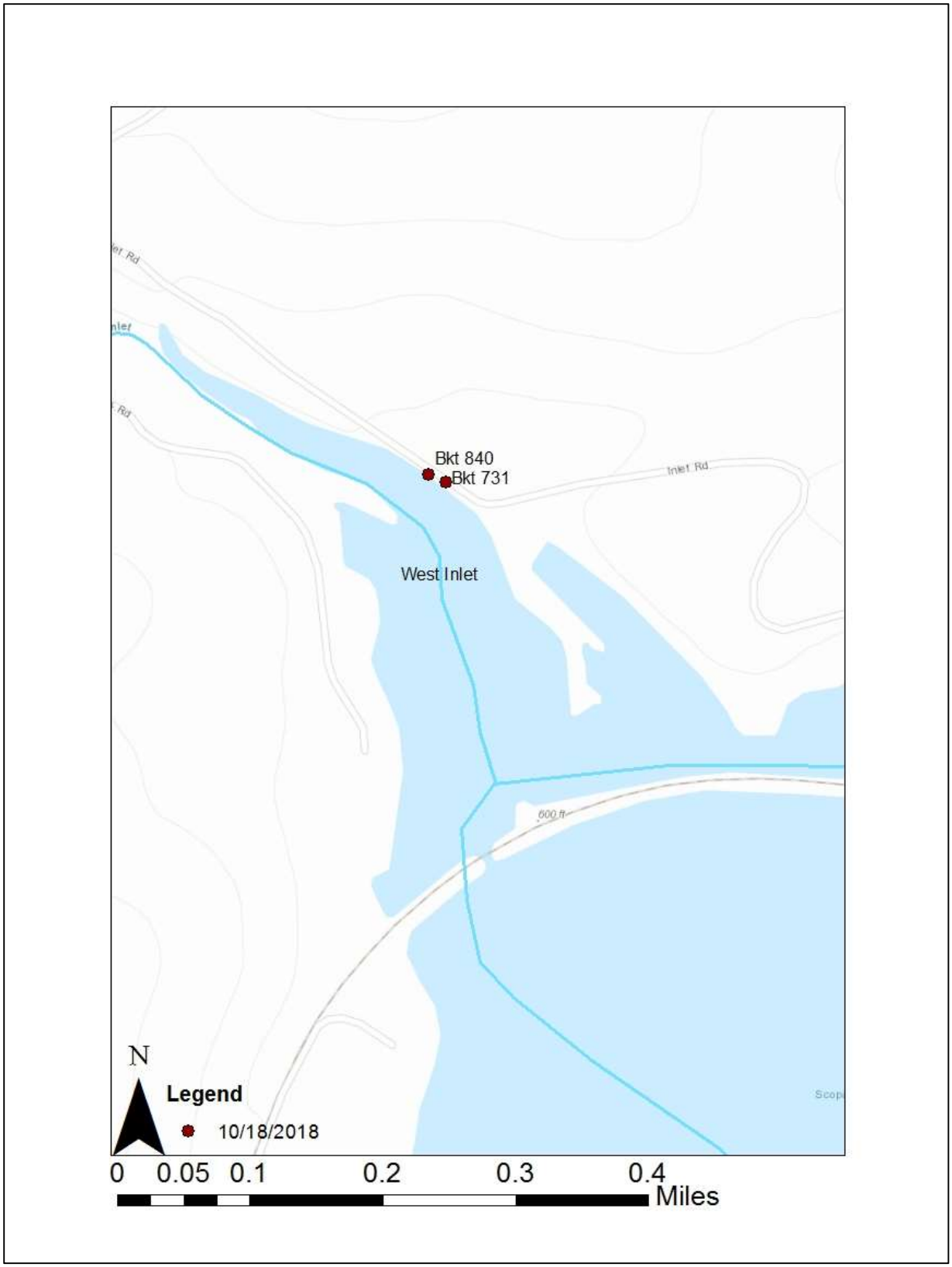

Figure 3. Tracking location for BKT #731 and #840 found during a 6.75-hour tracking event on foot on October 18th.

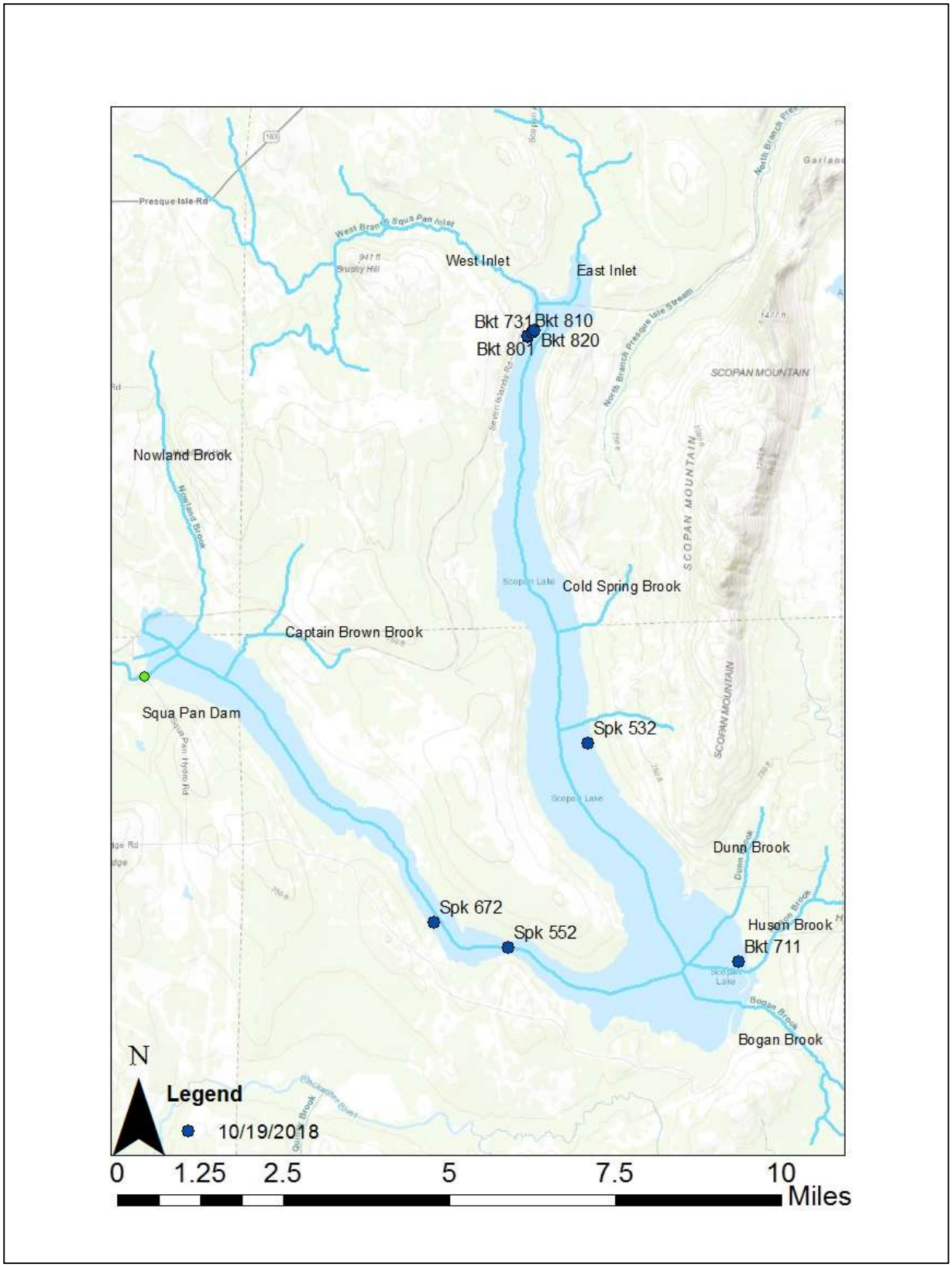

Figure 4. Tracking location for eight fish found during a 9-hour tracking event on October 19th.

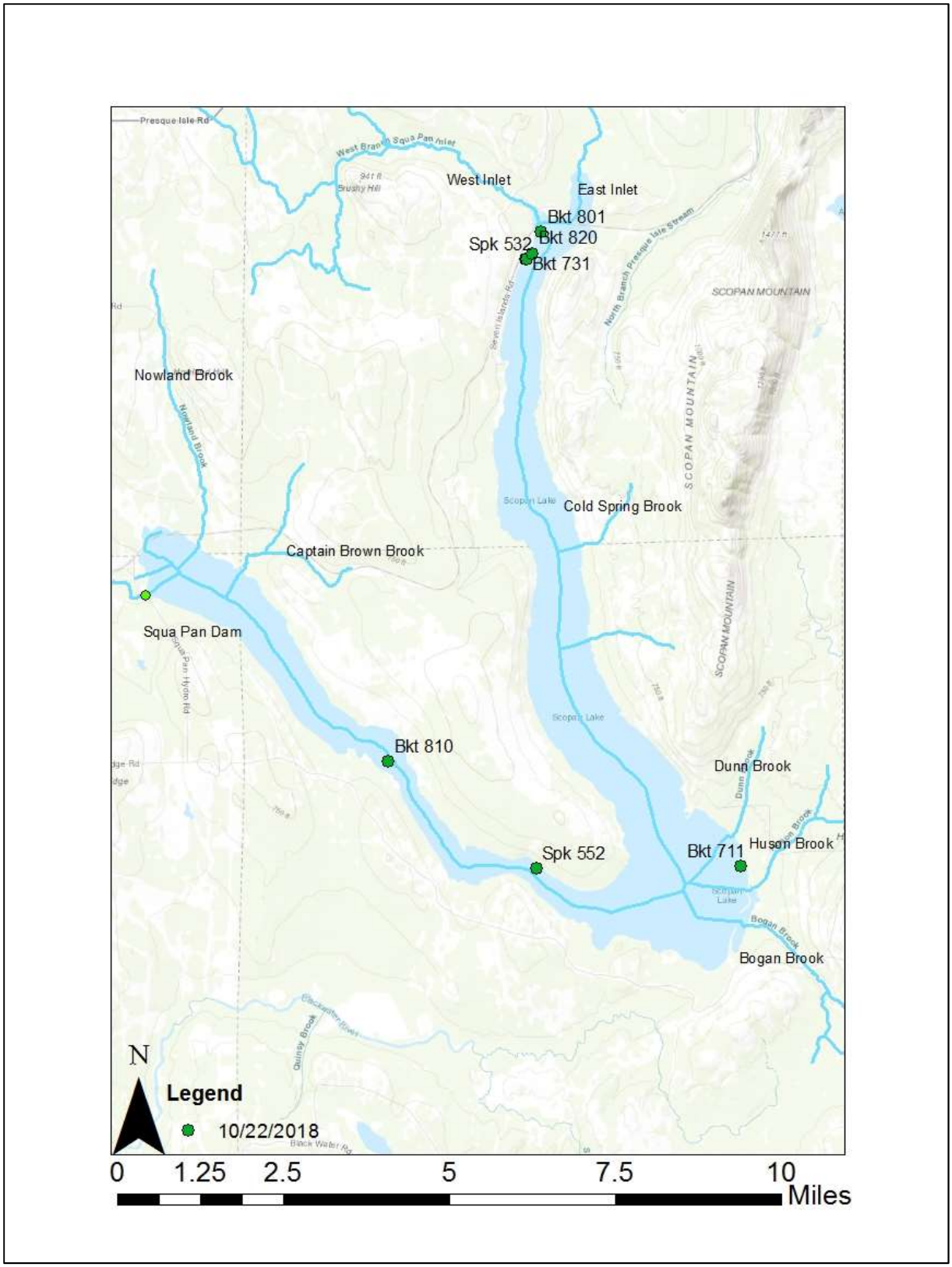

Figure 5. Tracking location for seven fish found during an 8.5-hour tracking event on October 22nd.

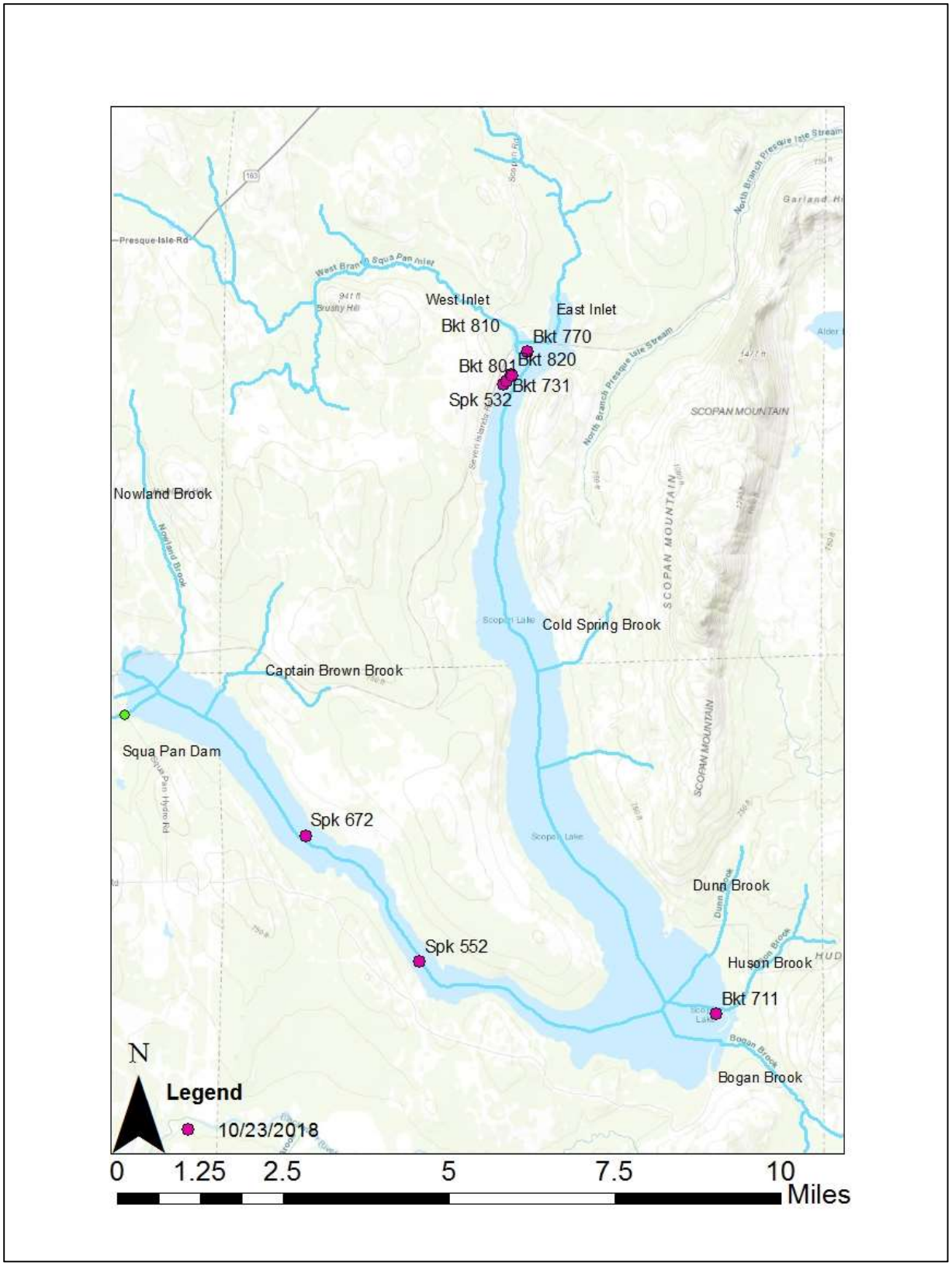

Figure 6. Tracking location for nine fish found during a 9.5-hour tracking event on October 23rd.

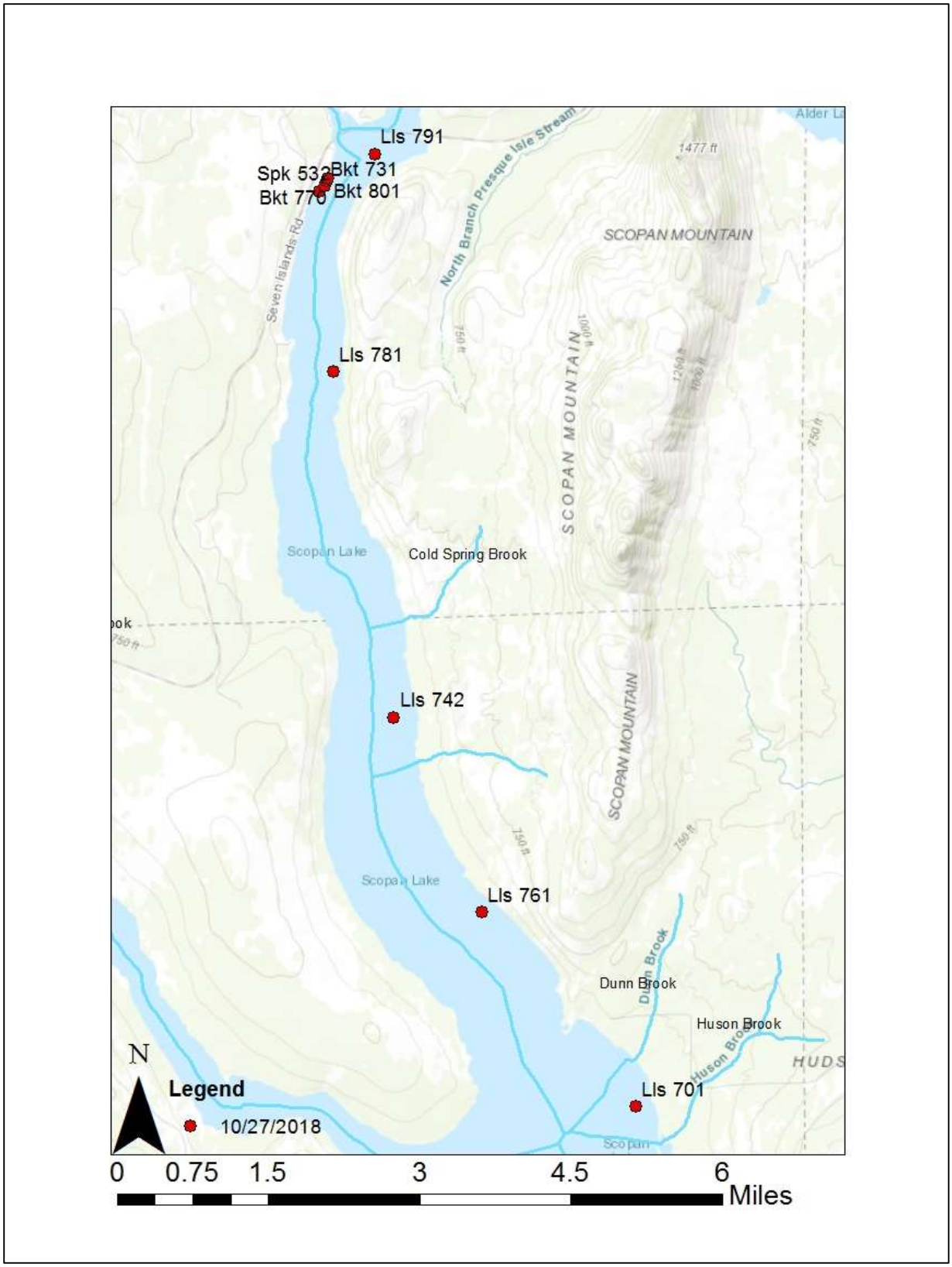

Figure 7. Tracking location for nine fish found during a 7.25-hour tracking event on October 27th.

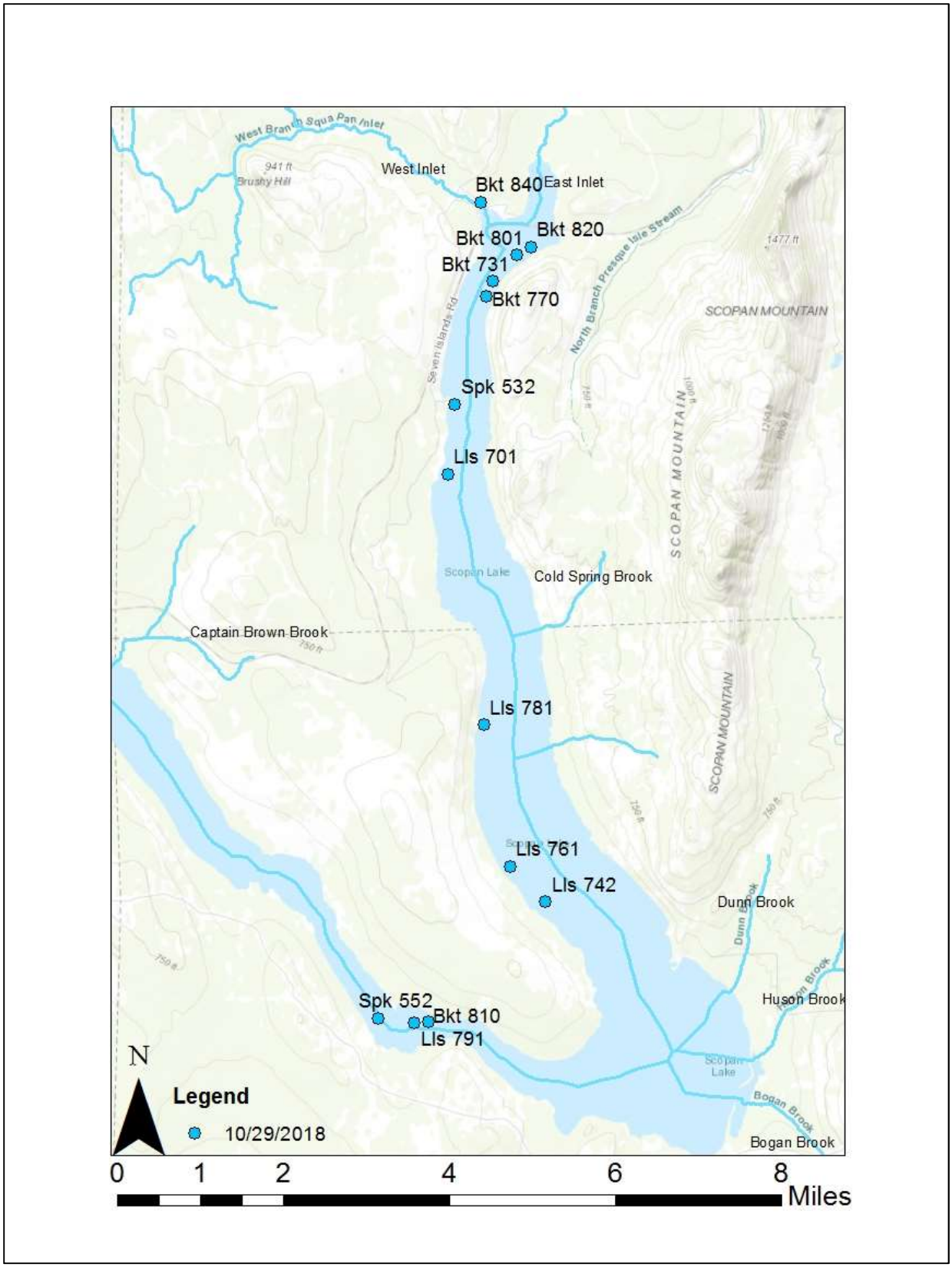

Figure 8. Tracking location for 13 fish found during a 7-hour tracking event on October 29th.

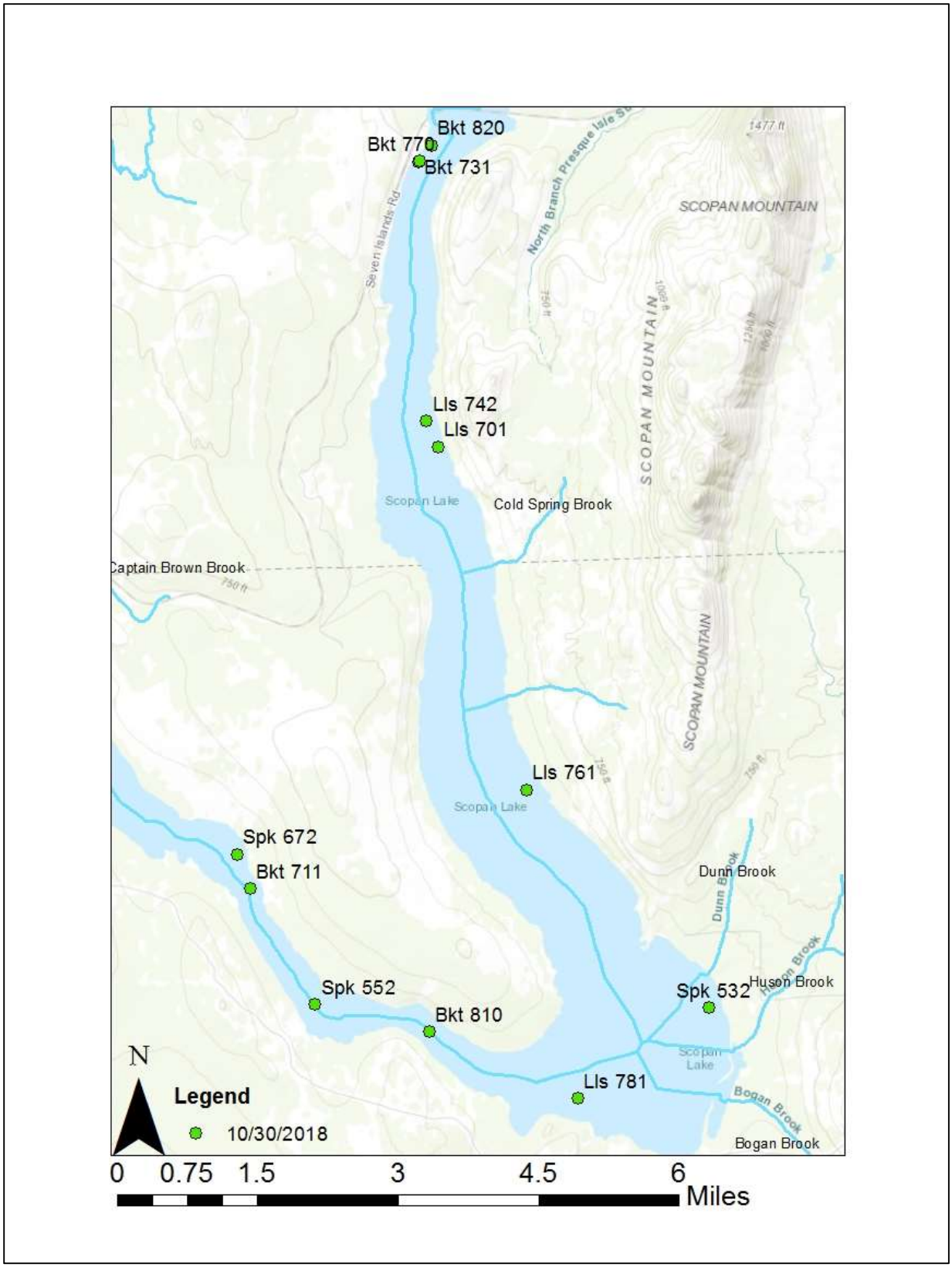

Figure 9. Tracking location for 12 fish found during 7.25-hour tracking event on October 30th.

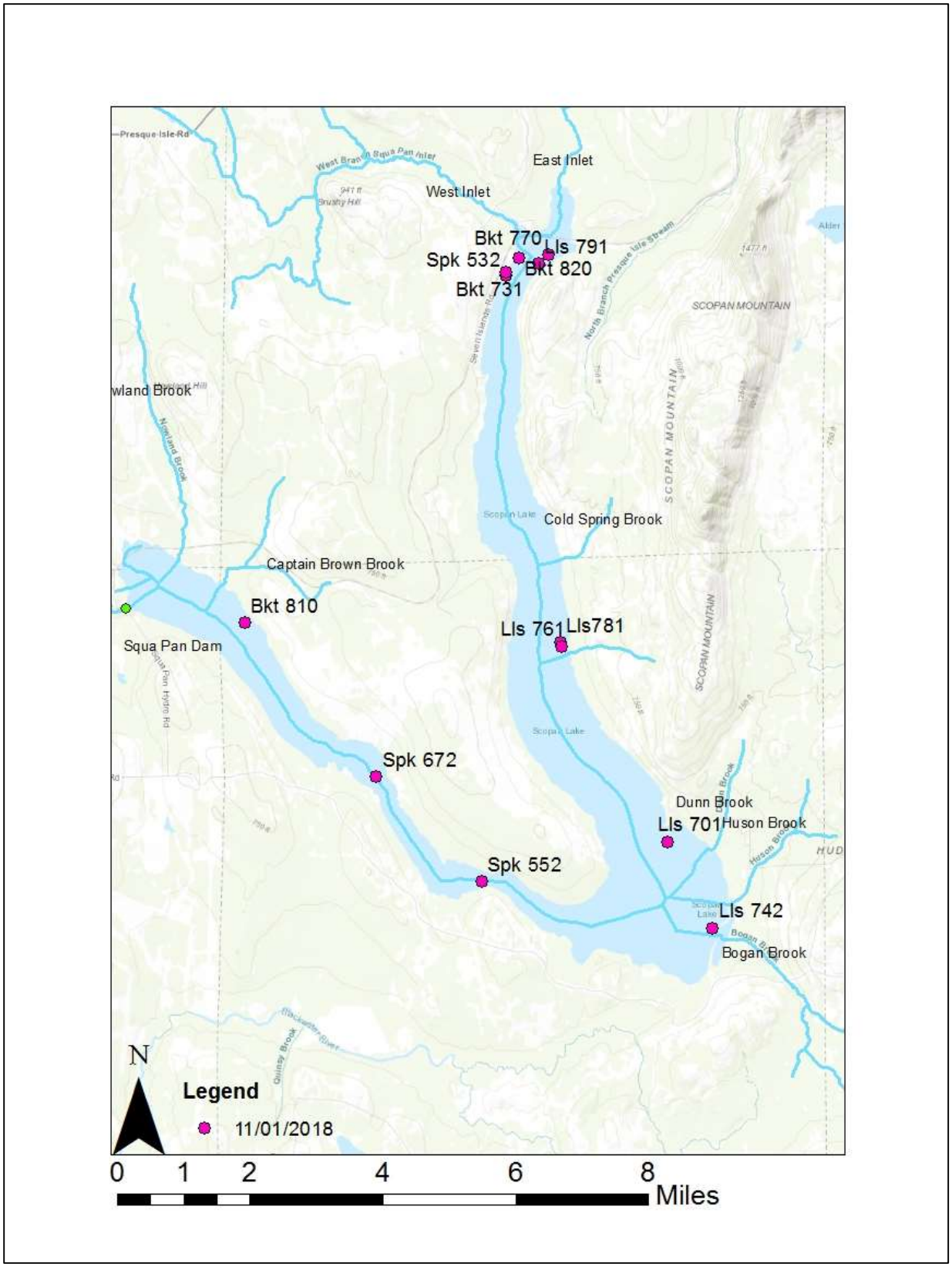

Figure 10. Tracking location for 12 fish found during an 8-hour long tracking event on November 1st.

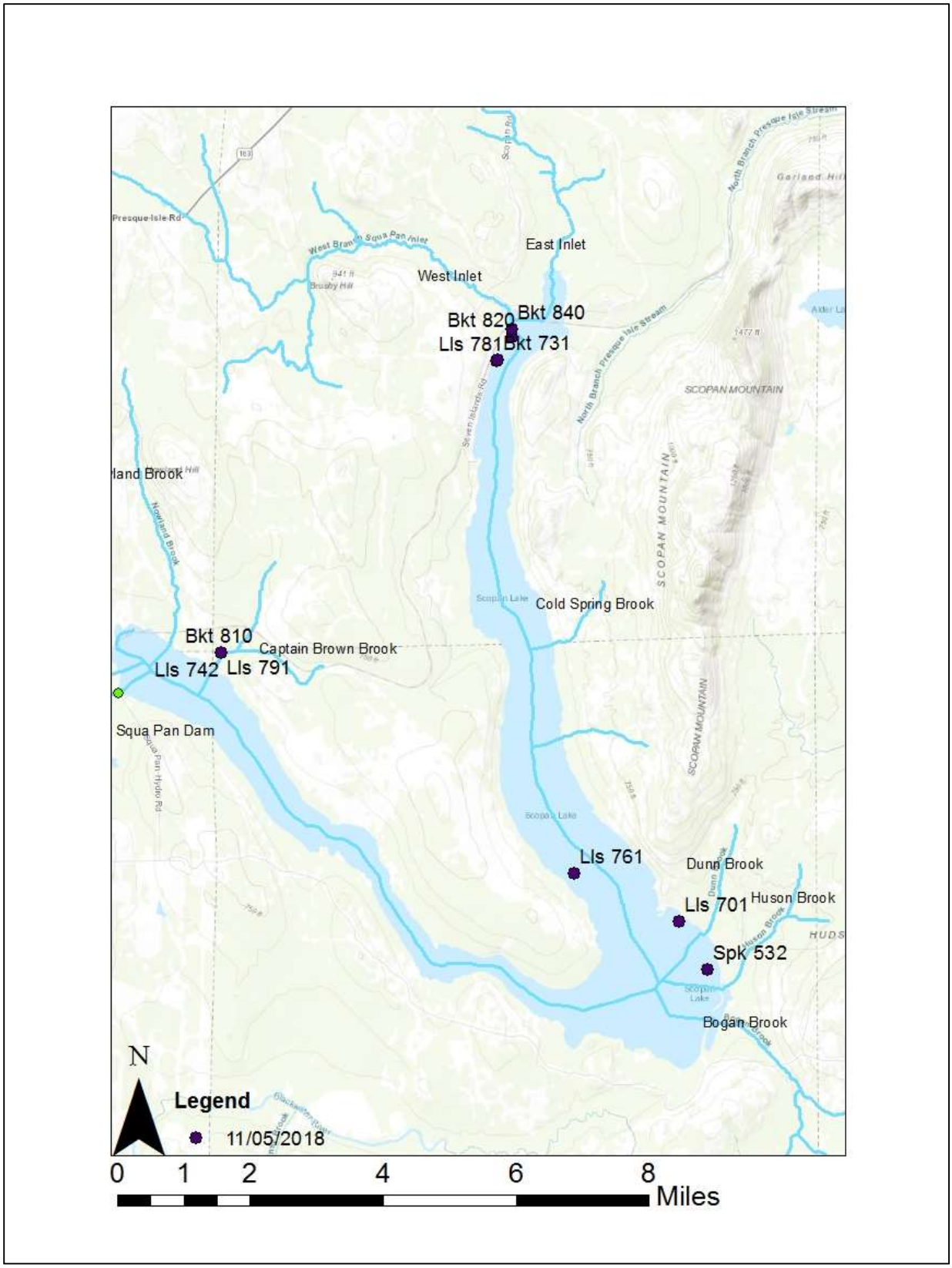

Figure 11. Tracking location for 10 fish found during a combined tracking time of 10.33 hours on November 5th.

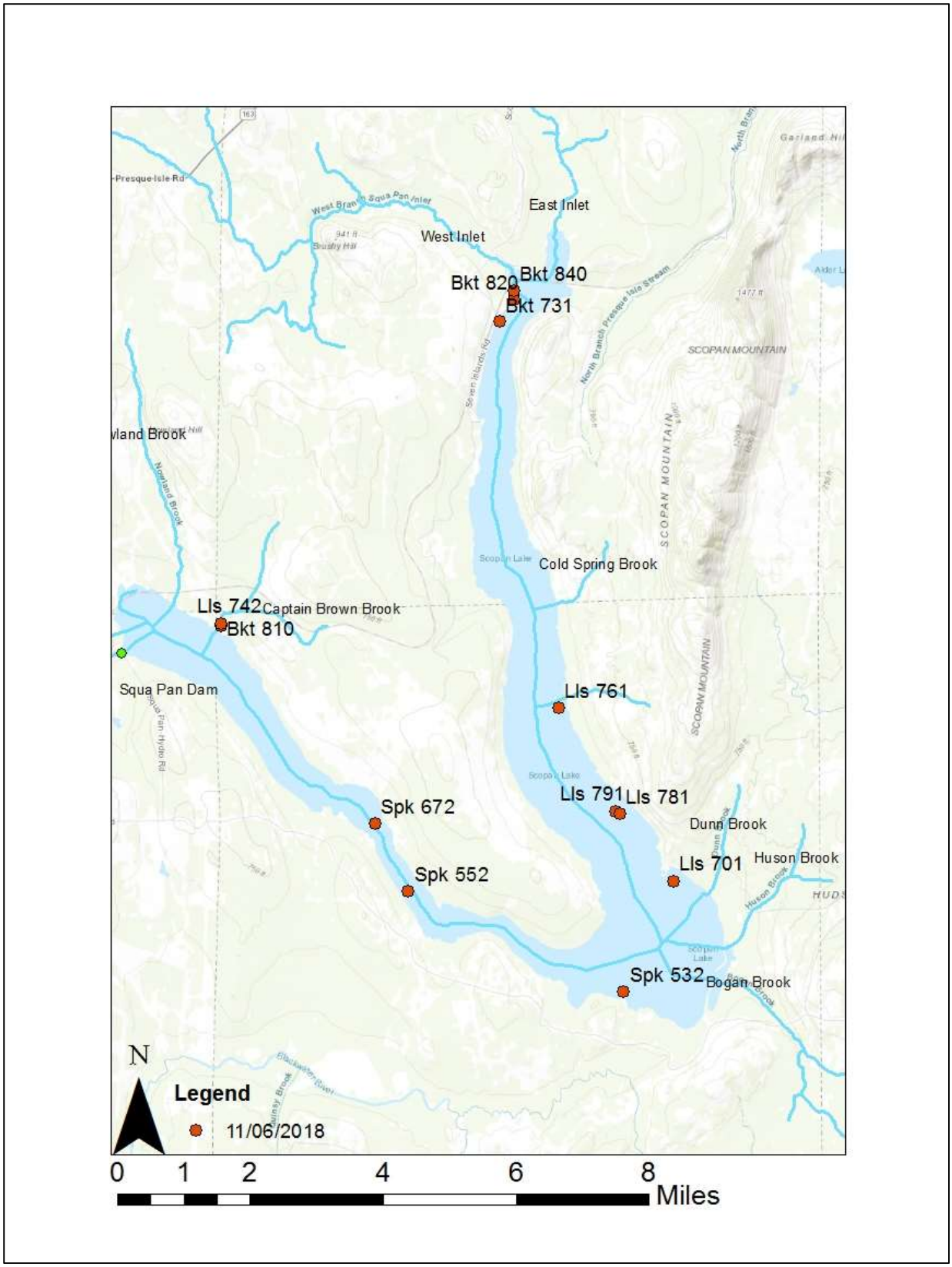

Figure 12. Tracking location for 12 fish found during a 7.5-hour tracking event on November 6th.

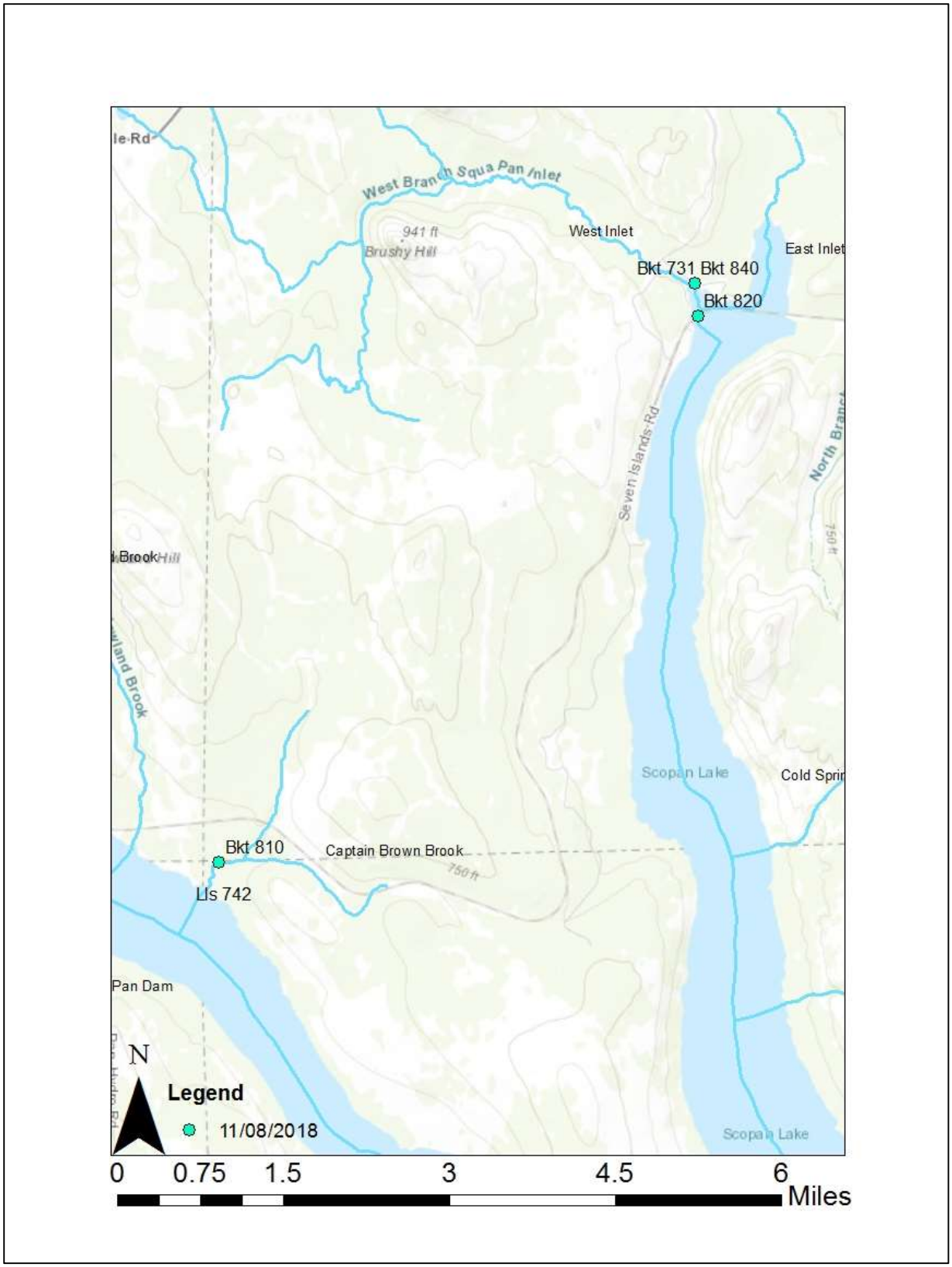

Figure 13. Tracking location for five fish found during a 6.5-hour tracking event by foot on November 8th.

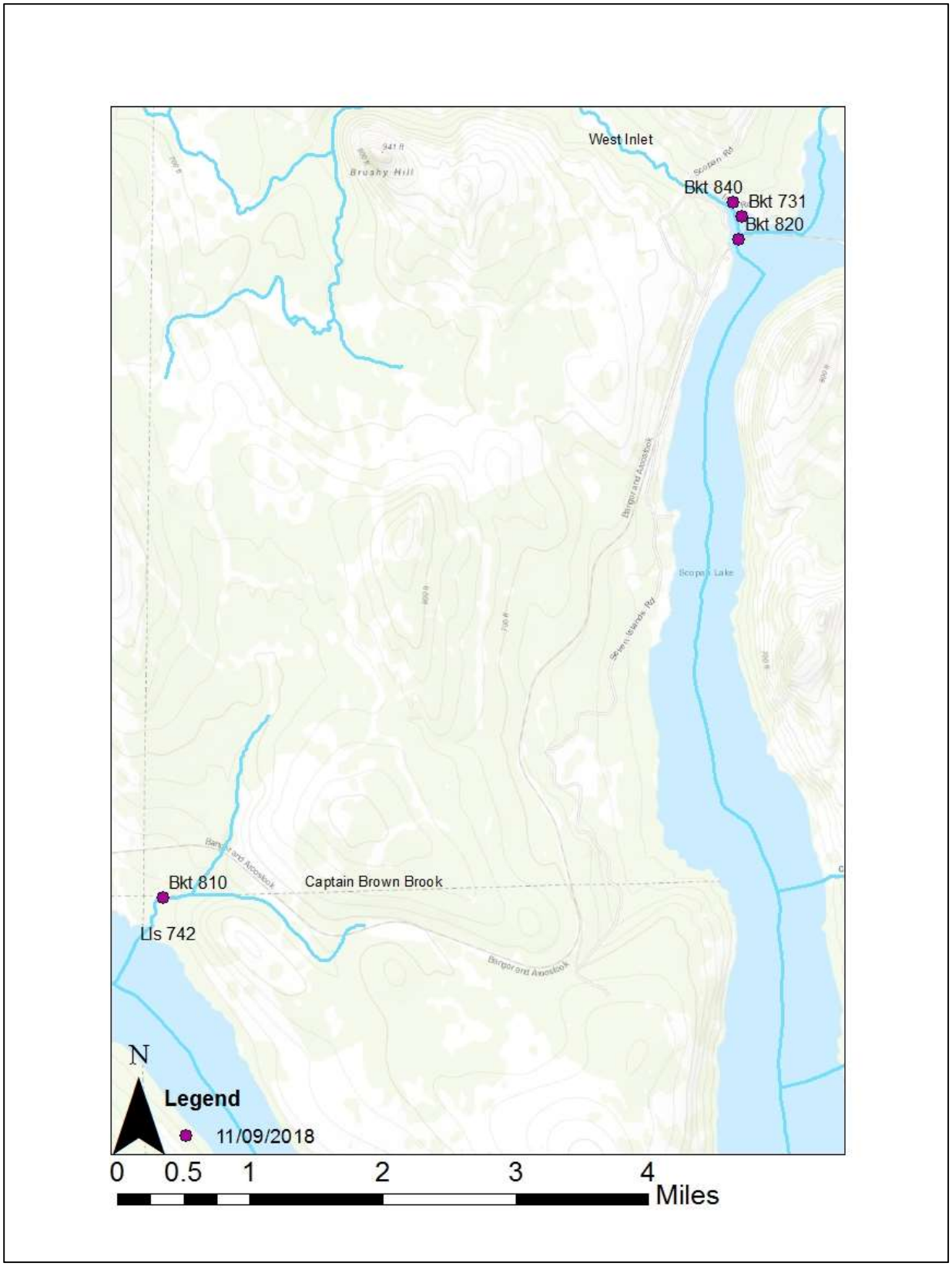

Figure 14. Tracking location for five fish found during a 6-hour tracking event on November 9th. All fish except for BKT #820 were confirmed dead on this date.

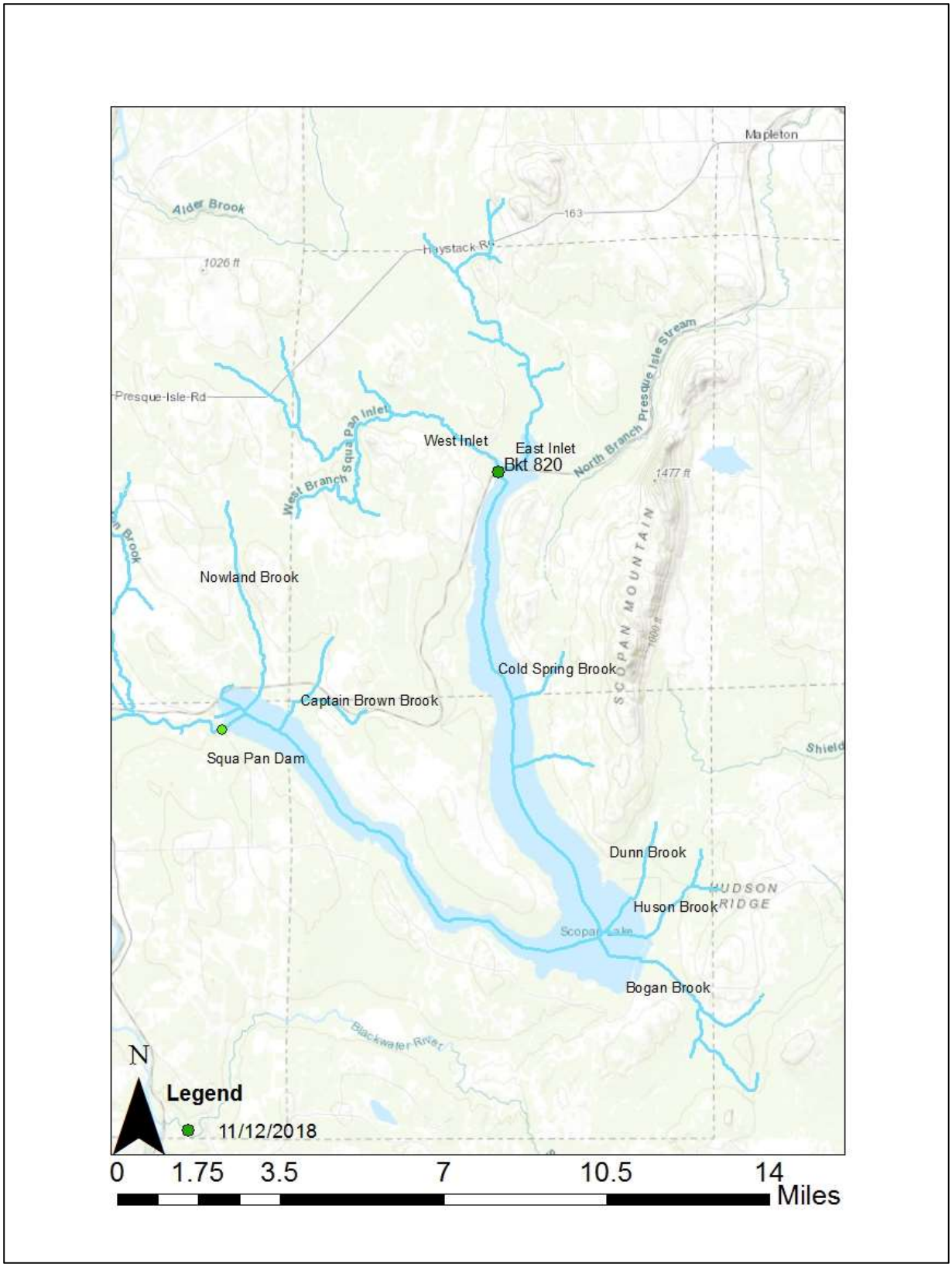

Figure 15. Tracking location for BKT #820 found during a 4-hour tracking event on November 12th.

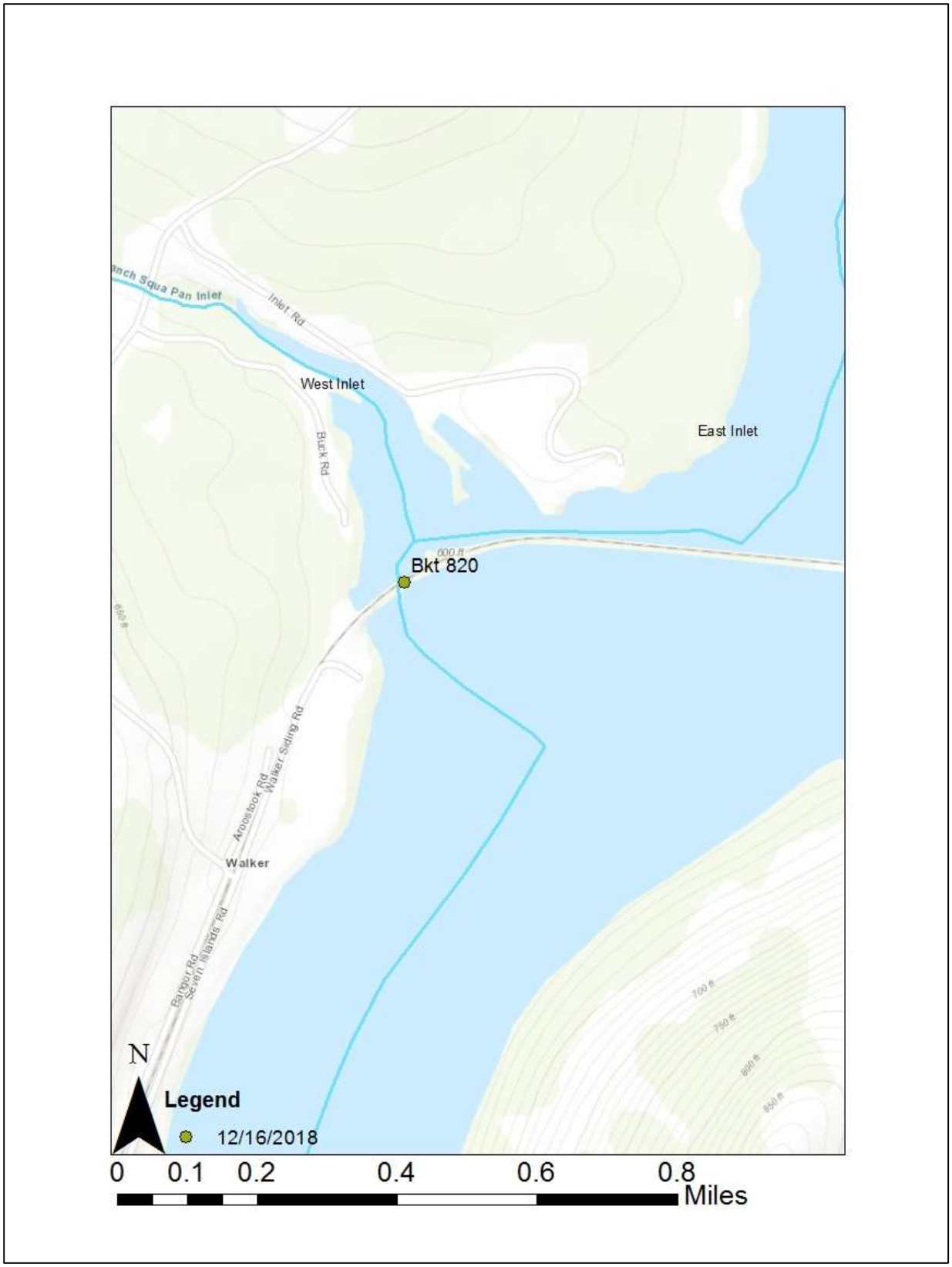

Figure 16. Tracking location for BKT #820 found during a half hour tracking event on December 16th. This fish was confirmed dead on this date.

COOPERATIVE

STATE  FEDERAL

PROJECT

This report has been funded in part by the Federal Aid in Sport Fish Restoration Program. This is a cooperative effort involving federal and state government agencies. The program is designed to increase sport fishing and boating opportunities through the wise investment of angler's and boater's tax dollars in state sport fishery projects. This program which was founded in 1950 was named the Dingell-Johnson Act in recognition of the congressmen who spearheaded this effort. In 1984 this act was amended through the Wallop Breaux Amendment (also named for the congressional sponsors) and provided a threefold increase in Federal monies for sportfish restoration, aquatic education and motorboat access.

The program is an outstanding example of a "user pays-user benefits" or "user fee" program. In this case, anglers and boaters are the users. Briefly, anglers and boaters are responsible for payment of fishing tackle, excise taxes, motorboat fuel taxes, and import duties on tackle and boats. These monies are collected by the sport fishing industry, deposited in the Department of Treasury, and are allocated the year following collection to state fishery agencies for sport fisheries and boating access projects. Generally, each project must be evaluated and approved by the U.S. Fish and Wildlife Service (USFWS). The benefits provided by these projects to users complete the cycle between "user pays – user benefits."

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