

## **Columbia River Project Water Use Plan**

### **Kinbasket Reservoir Fish and Wildlife Information Plan**

#### ***Kinbasket Reservoir Burbot Life History and Habitat Use Assessment***

#### **Implementation Year 3**

#### **Reference: CLBMON-05**

**WLR Monitoring Study CLBMON-05 (Year 3) - Kinbasket Reservoir Burbot Life History and Habitat Use Assessment**

**Study Period: April 2016 to Nov 2016**

**Canadian Columbia River Inter-Tribal Fisheries Commission.  
7468 Mission Rd, Cranbrook, BC, V1C 7E5**

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**WLR Monitoring Study CLBMON-05 (Year 3)**

**Kinbasket Reservoir Burbot Life History and Habitat Use Assessment**



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Cover Photo:

Cod trap with Burbot caught from Kinbasket Reservoir during spring capture session 2014. Photos in this document from Scott Cope, Westslope Fisheries, Ltd.

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## EXECUTIVE SUMMARY

Burbot (*Lota lota*) were historically distributed throughout the Columbia and Canoe Rivers, and Kinbasket Lake, which were impounded by the construction of Mica Dam in 1973. Mica Dam created Kinbasket Reservoir, a 216 km long, 43,200 ha ultraoligotrophic water body. Burbot are present throughout Kinbasket Reservoir. This technical report summarizes the findings of the second year of a four year monitoring study (2014-2017) of their life history and habitat use. A more in-depth quantitative analysis of Burbot detections will be conducted in the final report, along with an assessment of impacts of dam operations.

Kinbasket reservoir has a normal operating range of approximately 35 m. The reservoir experiences rapid drawdown during the winter months from January to April, when reservoir elevations decline by an average of 4.3 m/month. Burbot spawn during this time period, and the success of their spawning may be affected by declining water levels. Burbot often spawn in shallow water, and developing eggs require several weeks to develop before hatching, at which time larvae spend several days resting in substrate before becoming planktonic. It is during this time period that optimal spawning habitat, developing eggs or newly hatched larvae may become stranded by declining water levels in Kinbasket Reservoir. The fact that Burbot still exist in Kinbasket Reservoir implies that their population persists, however, anecdotal evidence suggests there has been a declining population trend over the last two decades. One hypothesis is that spawning success of a component of the population may be affected by operations.

This study uses biotelemetry to determine biological characteristics, movement and depth preferences of Burbot during the period of time that spawning is expected to occur. Previous data on capture rates and logistical constraints limited the capture locations to seven areas focused between the Canoe Arm and Surprise Rapids. Burbot were captured by baited cod traps during the immediate post-spawning period of late April and early May, 2014 and 2015, shortly after ice-off and during the period of minimum reservoir elevation. Capture was conducted in 48 h soaks, in shallow depths (< 20 m) to minimize decompression trauma of captured fish.

Ninety-eight (98) Burbot of a broad size range (0.84 – 4.60 kg) were surgically implanted (Spring 2014 and Spring 2015) with combined acoustic-radio transmitters (CART) that transmit depth and temperature sensor data. These fish were tracked year-round by fixed acoustic receivers from Spring 2014 to Spring 2016. Sixteen fixed acoustic receivers were redeployed in May 2015 and 14 new receivers were deployed in July 2015. Aerial radio tracking had been attempted in Winter/Spring 2015 but has since been discontinued due to poor detection rates. Receivers were placed in areas designed to detect broad scale movements and in the vicinity of stream confluence areas that are suspected spawning areas. Burbot depth and water temperature data were recorded by receivers year-round and used to determine movements towards spawning areas and depths used during the spawning season.

Mobile and fixed receiver tracking data collected from 2014 to 2016 indicated no clear movement pattern towards a specific congregation location in the pre-spawning and early spawning season. While data from fixed acoustic receivers indicated variability in the depths occupied by Burbot, significant



differences among seasonal depth use patterns were observed in shallower habitat (approximately <16 m) use during assumed periods of spawning and deeper habitat use (approximately >19 m) during fall/early winter. These trends are consistent with movements from deep areas during Fall-Winter and subsequent movements to shallow areas during the expected spawning period in Spring-Summer.

A thorough assessment of Burbot detection data (for all years) will be evaluated in Year 4, as well as an analysis of potential impacts of drawdown on spawning success.

<b>Management Question</b>	<b>Hypotheses</b>	<b>Status (2015; Year 2)</b>
What are some basic biological characteristics of Burbot populations in Kinbasket Reservoir (e.g., distribution, abundance, growth and age structure)?		Distribution and abundance of Kinbasket Burbot assessed in 2014 to 2016. To be further addressed in Year 4.
Does winter drawdown of Kinbasket Reservoir cause the dewatering of Burbot spawning habitat and affect spawning success?	H1: Winter drawdown of Kinbasket Reservoir causes dewatering of Burbot spawning habitat, which reduces egg survival and Burbot spawning success.  H2: Winter drawdown of Kinbasket Reservoir causes dewatering of access to Burbot spawning habitat in some years.	To be addressed in Year 4.
Can modifications be made to the operation of Kinbasket Reservoir to protect or enhance spawning success of these Burbot populations?		To be addressed in Year 4.

## **ACKNOWLEDGEMENTS**

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## INTRODUCTION

### Background

Kinbasket Reservoir was created by the construction of Mica Dam in 1973, under the terms of the Columbia River Treaty. The purposes of the creation of this earthfill, high head dam and reservoir were for optimized, coordinated power generation between Columbia River mainstem dams in the US and Canada and for downstream flood control. The reservoir inundated 216 km of the length of the Columbia River between Mica and Donald, and is among the largest reservoirs in British Columbia, with a maximum surface area of 43,200 ha. Prior to dam construction, the majority of this habitat was free flowing, with the exception of a lacustrine portion known as Kinbasket Lake that was 13 km long and had a surface area of 2,250 ha (Prince, 2011). The reservoir can be coarsely segregated into two main reaches, with the Columbia and Canoe reaches meeting at the historic confluence of the Canoe and Columbia rivers, where the Columbia River turns southward approximately where Mica Dam is currently situated. The reaches of the reservoir are typically bounded by steep valleys and are narrow, with stretches becoming riverine at low pool. Three large lacustrine portions of the reservoir occur at the confluence of the Canoe and Columbia Reaches, at the historic location of Kinbasket Lake near the confluence with the Sullivan River, and at the confluence with the Bush River. Stream inputs are largely glacial, draining the high elevation northern tips of the Selkirk and Monashee mountains from the West, and the extensively glaciated West slopes of the Canadian Rockies from the East.

Operations of Mica Dam result in Kinbasket reservoir elevations varying between a maximum of 754.38 m and a minimum 707.41 m, and being occasionally brought up to a maximum elevation of 754.68m if there is a high probability of spill. Normal operating level for the 2008-2012 period was from a mean maximum of 753.26 m and a minimum of 718.12 m, with a normal operating range of 35.14 m. Drawdown from full pool normally begins slowly in September, and draft rate increases through the winter, with a levelling off of drafting and normal low pool occurring in mid-late April. During the spring period, discharge from Mica dam decreases, which coincides with the normal spring freshet, which rapidly refills the reservoir through the spring and early summer.

Burbot (*Lota lota*) were identified by the Columbia River Water Use Plan Consultative Committee (WUP CC) as a key fish species of concern in Kinbasket Reservoir because of their importance to the sport fishery, because of the potential for links between reservoir operations and Burbot population productivity, and due to the dearth of information regarding Burbot biology in the reservoir (but see Harrison et al., 2013). The WUP CC hypothesized that the greatest potential impact of reservoir operations on Burbot populations may be the dewatering effect of winter drawdown on spawning success and egg survival in sites along the shoreline and in lower sections of tributaries. The WUP CC also had concerns that winter drawdown could affect Burbot spawning habitat in tributary streams of Kinbasket Reservoir. To address these concerns, the WUP CC recommended that a life history and habitat use assessment be undertaken in Kinbasket Reservoir to gain a better understanding of how the current operating regime might be affecting Burbot populations.

Burbot typically spawn between late January and April, with timing on major Columbia River system reservoirs (Duncan and Arrow) occurring in mid-February to early April (Arndt and Hutchinson, 2000;

Bisset and Cope, 2002; Prince and Cope, 2008; Cope, 2011; Robichaud et al., 2013), either in lake habitats or low velocity stream habitats, and have an egg incubation period of 30-60 days (Taylor and McPhail, 2000; McPhail, 2007). After hatching, larvae spend several days resting on the bottom before becoming free-swimming and planktonic in the water column. It can be expected that the period of spawning and egg and early larval development occurs between February and May-June in Kinbasket Reservoir, which coincides with the period when reservoir water levels can decline by an average of 4.3 m/month before reaching low pool elevation (Figure 1).

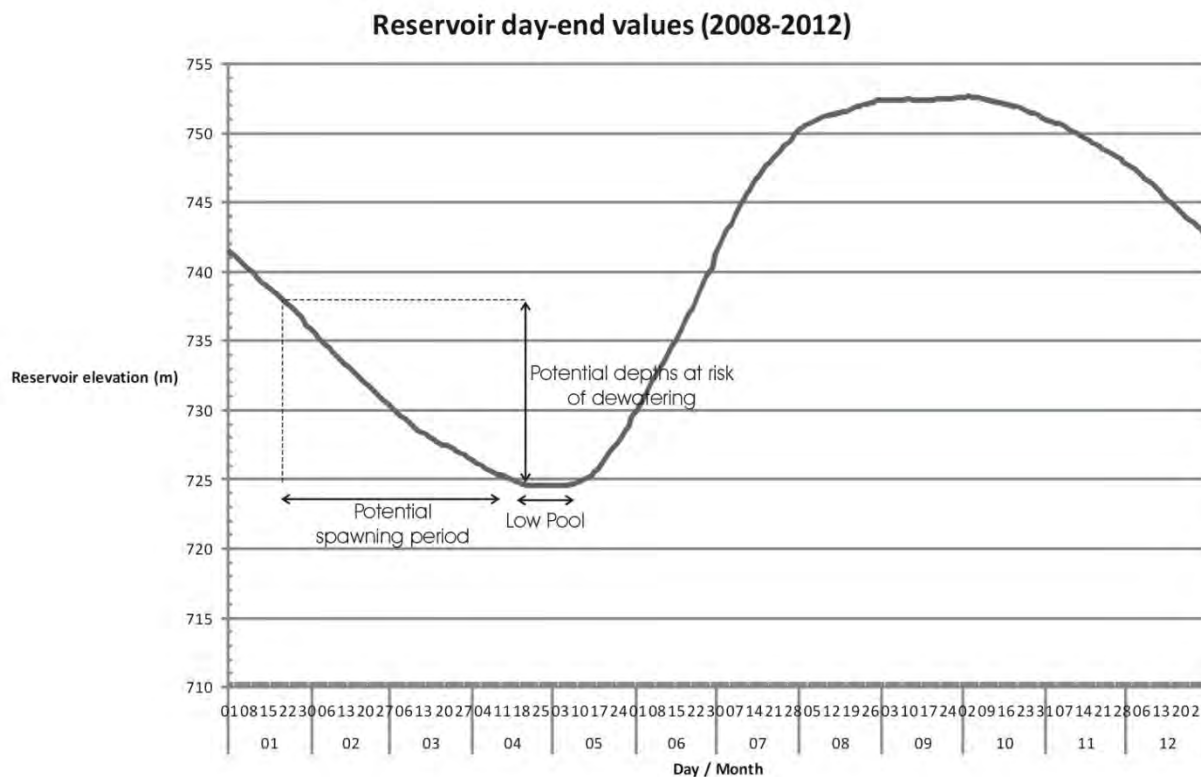


Figure 1: Potential depths used by Burbot during the spawning period that are at risk of dewatering in an average year of reservoir operation. Greater depths are at less risk for dewatering as the spawning season progresses. Line represents mean water elevation from 2008 to 2012.

The greatest potential impact of reservoir operations on Burbot populations may be the dewatering effect of winter drawdown on spawning success and egg survival in sites along the shoreline and in lower sections of tributaries. Burbot spawn in aggregations, often at night (McPhail, 2007), and vocalization appears to be a key behaviour that may aid Burbot in locating each other for spawning (Cott et al., 2014). In lakes and reservoirs, spawning may occur over near-shore shallows or over shallow offshore reefs and shoals (Ford et al., 1995; McPhail, 2007; Spence, 1999; Prince and Cope, 2008); however, deeper spawning (>20m) may also take place (Robichaud et al., 2013). In rivers and tributaries, Burbot spawn in low velocity areas in main channels and in side channels behind depositional bars (McPhail, 2007). In many cases, spawning in lakes is often associated with tributary confluences or

upwelling; however microhabitat preferences for spawning appears to be general, as Burbot may select a range of substrate, habitat characteristics and depths to spawn (Ford et al., 1995; McPhail, 2007; Andrusak, 1998; Baxter et al., 2002; Spence and Neufeld, 2002; Prince and Cope, 2008; Cope, 2011). The depth at which spawning takes place, coupled with the timing of spawning until the period of maximum drawdown in April, dictates whether there is a risk of spawning failure due to reservoir operations (Figure 1).

Declining water levels may also interfere with Burbot spawning migration and spawning activity. In a radio telemetry study of adult Burbot in Duncan Reservoir, the extent of spawning migration into the upper Duncan River appeared to be influenced by reservoir water levels and their impacts on back-flooding and stream velocity (Spence and Neufeld, 2002; Cope 2011). As back flooding from Duncan Reservoir declined, Burbot tended to move downstream into areas with lower water velocities than the locations they had abandoned. Since stream spawning Burbot tend to spawn in low velocity stream habitats (McPhail, 2007), the Burbot may have been moving downstream to more suitable lower velocity spawning sites. Burbot are known to have low swimming endurance and biotelemetry results in the Kootenay River below Libby Dam suggest that spawning migrations of Burbot in the Kootenay River may be disrupted by high flows produced during hydropower production and flood control (Paragamian, 2000).

The operational impacts of Mica Dam depend on the life history strategy of resident Burbot populations. As there is no pre-dam life history information available for Burbot populations in this area, assessment of impacts must rely on estimation based on habitat features, other species, and other Burbot populations. What is known is that there was habitat connectivity between the historic Kinbasket Lake and the upper Columbia watershed prior to dam construction and operation. The literature suggests that all three life history forms of Burbot (lacustrine, adfluvial, fluvial) often co-exist within the same system (McPhail, 2007) and this may have been the case for Burbot occupying the historic Kinbasket Lake and upper Columbia system that is now inundated by Kinbasket Reservoir. Adfluvial and lacustrine remnant life history forms may still be present, the population may be supported by fluvial immigrants from upstream sources, or a combination of life history forms may exist. The relative contributions or existence of these three life history forms to the current Kinbasket Burbot population is unknown.

While the life history and population status of Kinbasket Lake and Columbia River Burbot before dam construction are largely unknown, recent studies have provided some insights into important habitats and distribution of remnant stocks (Prince, 2001; Harrison et al., 2013). Growth rate is highly variable, as within other populations (Cope, 2011). Burbot capture is relatively consistent and successful in the confluence, Bush pool, and historic Kinbasket Lake areas of the reservoir, as well as near tributary confluences in the Sullivan, Bush and Wood arms and Hugh Allan Creek (Prince, 2001; Prince, 2011; Harrison et al., 2013). Most Burbot (~2/3 of fish captured in the confluence area between the Columbia and Canoe Reaches) appear to make limited seasonal movements, as well, diel vertical migration and shifts to shallower habitats in winter are common (Harrison et al., 2013). This suggests that there may be many, non-central spawning areas, and/or that fish may not spawn annually, a common observation for Burbot (Paragamian and Wakkinen, 2008), especially those in reservoirs (Dunnigan and Sinclair,



2008). Burbot that move out of the confluence area do not appear to migrate towards a central spawning area (Harrison, pers. comm.).

### **Management Questions**

The management questions (MQs) associated with this monitoring program are (BC Hydro, 2007):

- 1) What are some basic biological characteristics of Burbot populations in Kinbasket Reservoir (e.g., distribution, abundance, growth and age structure)?
- 2) Does winter drawdown of Kinbasket Reservoir cause the dewatering of Burbot spawning habitat and affect spawning success?
- 3) Can modifications be made to the operation of Kinbasket Reservoir to protect or enhance spawning success of these Burbot populations?

The monitoring program will provide a quantitative baseline dataset to establish basic biological characteristics of the Burbot populations in Kinbasket Reservoir. It will provide information on habitat use, life history and rough estimates of abundance, and possible factors affecting Burbot productivity. Specifically, the assessment will address uncertainty regarding the extent to which Burbot are present in the drawdown zone during the spawning season, and if these areas are at risk for dewatering during the operational years of the study. A comprehensive drawdown risk assessment will be conducted in Year 3.

### **Management Hypotheses**

The primary aim of this monitoring program is to provide baseline information on the Burbot population in Kinbasket Reservoir to better inform on the relationship between reservoir operations and recruitment. It is designed to specifically test the following hypotheses using assumptions of winter (January-April) habitat use being linked to spawning activity:

H1: Winter drawdown of Kinbasket Reservoir causes dewatering of Burbot spawning habitat, which reduces egg survival and Burbot spawning success.

H2: Winter drawdown of Kinbasket Reservoir causes dewatering of access to Burbot spawning habitat in some years.

### **Key Water Use Decision Affected**

Implementation of the proposed monitoring program will provide information to support more informed decision making with respect to the need to balance storage in Kinbasket Reservoir with impacts on fish populations in the reservoir. Specifically, it will provide the information that is required to support future decisions around maintaining the current operating regime or modifying operations to protect reservoir Burbot populations.

## **METHODS**

### **Overview, study objectives and limitations**

The general approach of this study draws upon the designs of previous Water Use Planning Burbot life history and habitat use studies, particularly CLBMON-31 (Glova et al., 2009, 2010; Robichaud et al., 2011, 2012, 2013) and DDMON-11 (Cope; 2009, 2010, 2011), and refines them.

The study is designed to answer the management questions (MQs) outlined in the previous section. Unfortunately, the main drawbacks of work on Kinbasket reservoir are the size of the system, and inability to conduct on-reservoir work during the spawning season in February-March, which differs from the conditions of the previous two Water Use Planning studies on Arrow and Duncan Reservoirs.

The study is concentrated in a reduced area of the reservoir, between the Wood Arm and Surprise Rapids (Figure 2). This reduced area was chosen based on previous information of Burbot occurrence and logistical considerations for working from the only accessible boat launch near Mica Dam during the low pool period. During the Burbot spawning season, Kinbasket reservoir has unpredictable, dynamic ice conditions that make on-reservoir winter work unsafe. In addition, the remoteness of the reservoir requires extensive travel with limited safe access and contact points. Given these safety and logistical constraints, the following study design attempts to answer MQs 2 and 3 without working on-reservoir during the spawning season, and uses a combination of fixed receiver and mobile helicopter tracking. These methods attempt to infer whether fish are present and congregating in shallow drawdown habitats during the spawning season. This approach cannot confirm spawning activity, thus presence of aggregations of Burbot and movement to relatively shallow depths over multiple days during the potential spawning period are treated as indicative of potential spawning activity when testing the management hypotheses outlined in the previous section.

### **Burbot Capture/Tagging and Fixed Receiver Tracking**

Capture, tagging and mobile/fixed receiver tracking methodologies are outlined in the Year 1 and Year 2 reports. A total of 48 Burbot were tagged in 2014 (Year 1) and 50 Burbot were tagged in 2015 (Year 2). See Figure 3 for capture locations.

Analyses of both mobile and fixed receiver tracking were conducted in Year 2 of the project. Due to limited detection of Burbot from mobile tracking in Year 1, mobile tracking was discontinued and 16 more receivers were deployed during redeployment of original receivers in 2015 (total number of receivers was 30) for Year 3 analyses. Five original receivers were not retrieved in 2015 so new receivers were set in locations to replace these receivers. See Figure 3 for receiver locations.

Given premature battery failure of receivers deployed in 2014, batteries were reprogrammed to transmit every 140 or 180 s, depending on battery life of the previous monitoring period.

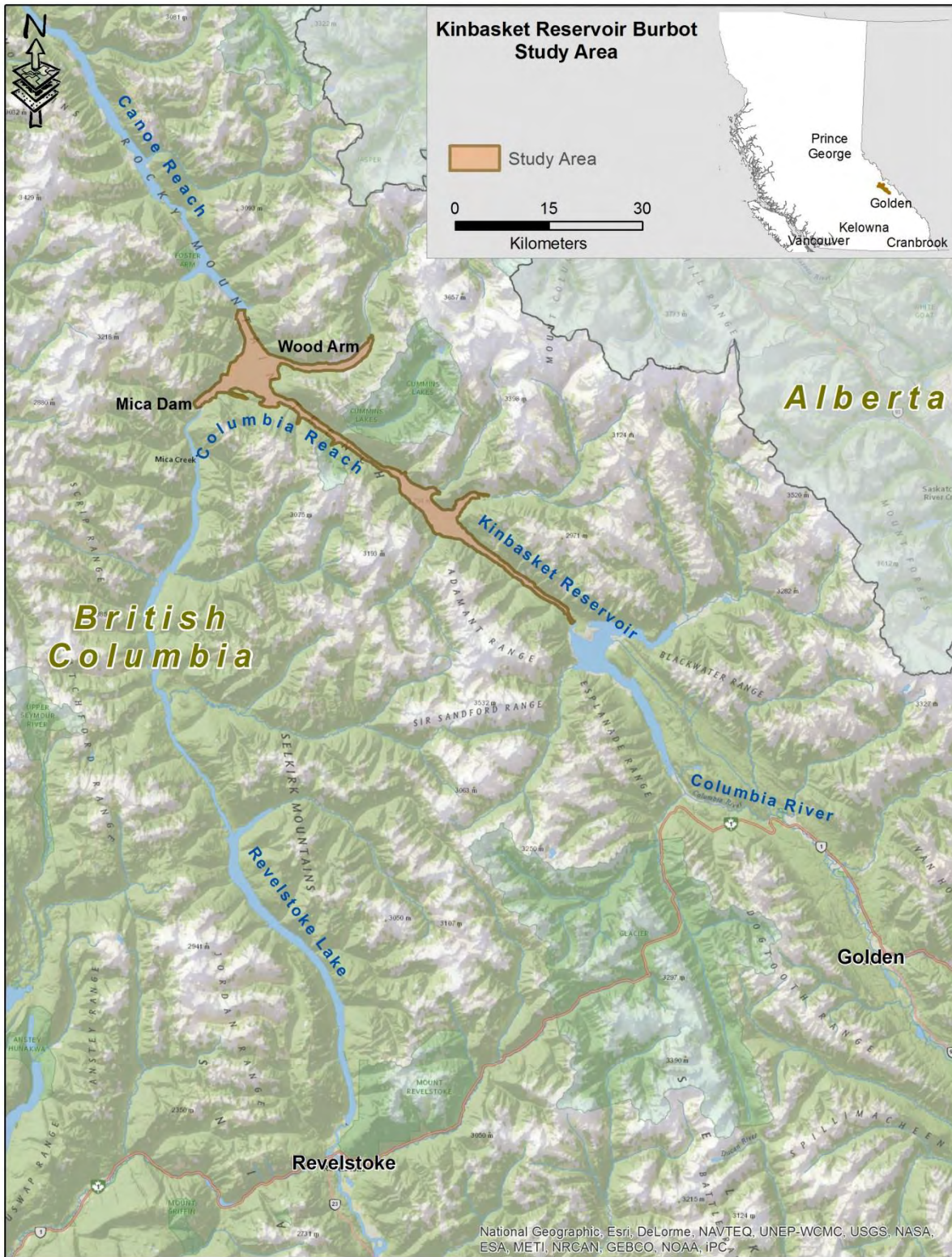
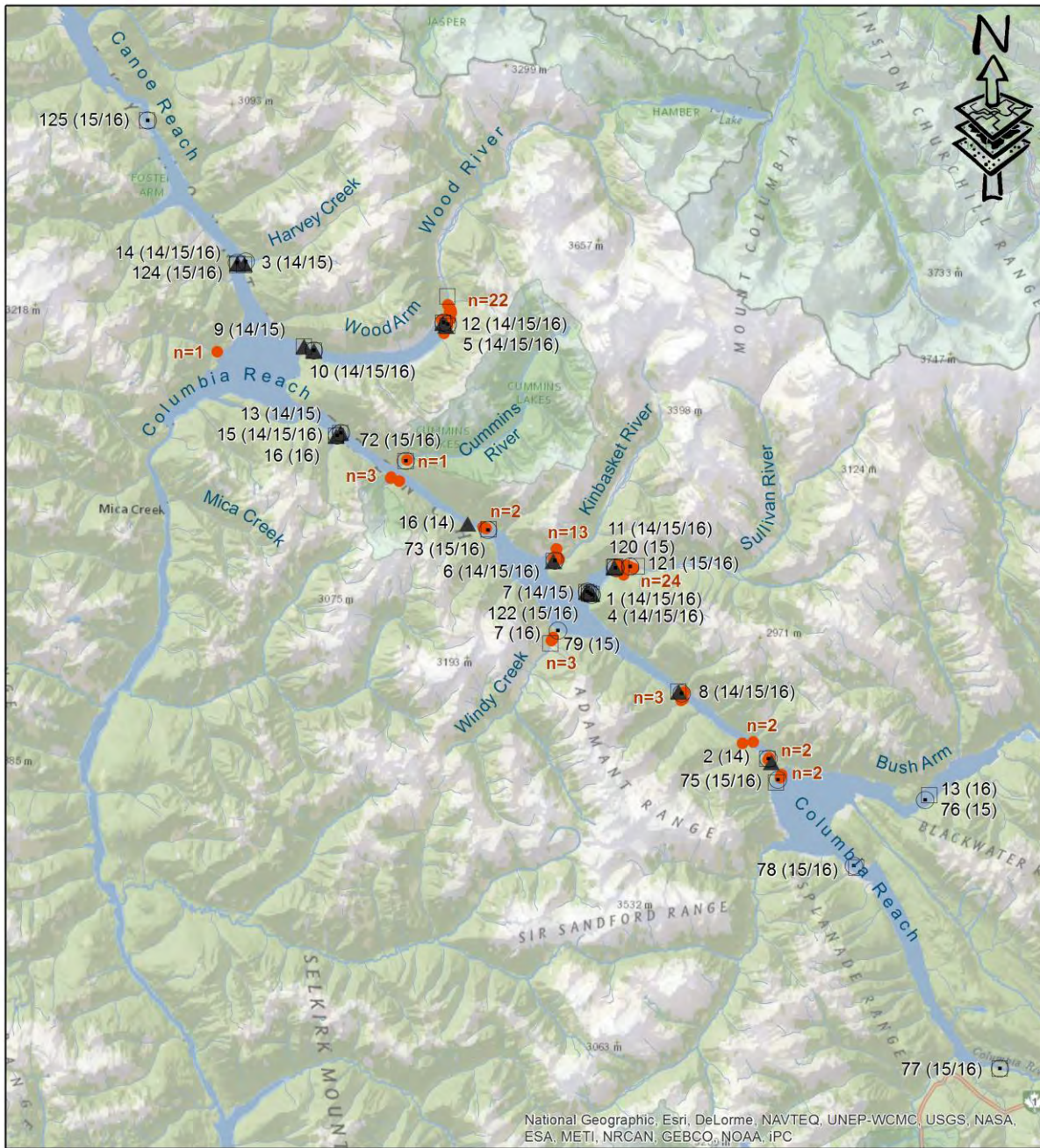


Figure 2: Study area within Kinbasket Reservoir





**Kinbasket Reservoir Burbot Tracking Overview Map**

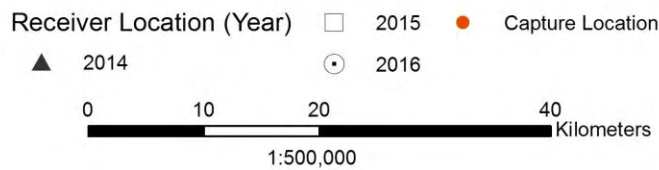


Figure 3: Locations of Burbot captures (orange circles with numbers of captures; 12 general areas) and acoustic receivers (n=30) within Kinbasket Reservoir study area. Receivers deployed in 2014 are marked with black triangles, receivers deployed in 2015 are marked with squares, and receivers deployed in 2016 are marked with dotted circles.

## RESULTS

### Fixed receiver tracking

This report summarizes information collected from tracking information collected from fixed receivers retrieved from April to May 2016 ( $n = 24$ ; comprises 20 receivers with 2015-2016 data and 4 receivers with 2014 -2015 data; 6 receivers were not recovered). Additionally, results from the 11 (of 16) receivers retrieved in 2015 are discussed in Kang et al., 2015.

Although batteries of receivers deployed in 2015 (excluding the 5 that were not recovered in 2015) were reprogrammed to save battery life when batteries failed prematurely in Year 2, 9 receiver batteries (out of 20) failed before the conclusion of the monitoring period, some as early as Sept. 30, 2015. Table 1 presents the start and end dates of data recording. Fortunately, 11 receivers located in suspected spawning areas collected data during the period when spawning is expected to occur (January to April). Receiver 16 (located at the Kinbasket Lake northern outlet) did not detect any Burbot tags; however, it did collect data from its ID beacon and the test tag used for range tests during its operation period indicating that it was properly functioning.

Table 1: Summary of monitoring period of fixed acoustic receivers deployed in Kinbasket Reservoir (listed according to locations from North to South). Data were downloaded from Apr. 30 to May 7, 2016. Receivers in *italics* were not recovered in 2015 (Year 2) and provide supplemental information to Year 2 report findings.

Receiver ID	Location	Start of Monitoring	End of Monitoring	Number of Detections
125	Upper Canoe Reach	10-Jul-15	24-Apr-16	382
<i>14</i>	<i>Lower Canoe Reach</i>	<i>29-May-14</i>	<i>13-Feb-15</i>	<i>96</i>
124	Lower Canoe Reach	30-Jun-15	28-Apr-16	1861
10	West Wood Arm	11-May-15	15-Feb-16	2425
12	South Wood River	13-May-15	20-Mar-16	61888
5	North Wood River	14-May-15	01-May-16	43519
15	West Columbia Reach	14-May-15	19-Feb-16	752
13	East Columbia Reach	11-May-15	19-Feb-16	1498
112	Cummins River	10-Jul-15	02-May-16	6891
<i>16</i>	<i>Kinbasket Lake Outlet</i>	<i>28-May-14</i>	<i>26-Jan-15</i>	<i>40</i>
113	Kinbasket Lake Outlet	09-Jul-15	02-May-16	10626
6	Kinbasket River	12-May-15	10-Jan-16	37003
08	Kinbasket Lake Inlet	13-May-15	04-May-16	26961
7	<i>South Sullivan Arm</i>	<i>29-May-14</i>	<i>02-Apr-15</i>	<i>7574</i>
122	South Sullivan Arm	08-Jul-15	02-May-16	1670
4	Middle Sullivan Arm	12-May-15	02-May-16	3728
1	North Sullivan Arm	12-May-15	09-Mar-16	2183

11	Sullivan River	29-May-14	12-Feb-15	79033
121	Sullivan River	17-Jul-15	14-Jan-16	14056
115	Surprise Rapids	10-Jul-15	06-May-16	58036
114	Surprise Rapids	10-Jul-15	28-Apr-16	242
116	Bush Arm	17-Jul-15	15-Dec-15	911
118	Esplanade Bay	17-Jul-15	01-May-16	31
117	Columbia River	10-Jul-15	30-Sep-15	69

Range tests conducted after receiver installation with a test tag indicated detection efficiency was high. Receivers detected the test tags during all drifts conducted between 100 and 750 m from receivers at a range of depths. Receivers also detected nearby receivers in narrowings where the reservoir was gated, indicating that these areas had excellent coverage to detect movements of Burbot between reservoir areas.

Of 98 Burbot tagged in 2014 and 2015, 84 were detected by acoustic receivers. Detection rates for Burbot tagged in 2014 was 88% (42/48) while detection rates for BB tagged in 2015 was 84 % (42/50). Most movement detections occurred near the location of capture (Table 2; Appendix 1 and 2) with most detections occurring at receivers 12 (22%; Wood River), 5 (18%; Wood River), 6 (17%; mouth of Kinbasket River), and 11 (12%; Sullivan River). These locations also correspond to the locations of capture of 70% of the detected Burbot. Although most detected Burbot (66%) remained close to their location of capture, indicating sedentary behaviour, others were more active (34%) and exhibited movement throughout the study area (e.g., Burbot with acoustic codes 29500, 29600, 29800, 30900, 31200, 33000, 33500, 34300, 34600, 35000, 38300).

While the majority of detections at receivers were made at Wood River all year-round, detections did vary seasonally (Figure 4): >20% of detections were made at Sullivan Arm/River from November to February (late fall to winter) while >20% of detections from March to May (spring) were made at Kinbasket Lake/River areas; from June to October (late spring to fall), >20% of detections were made at Kinbasket River and Sullivan River receiver locations.

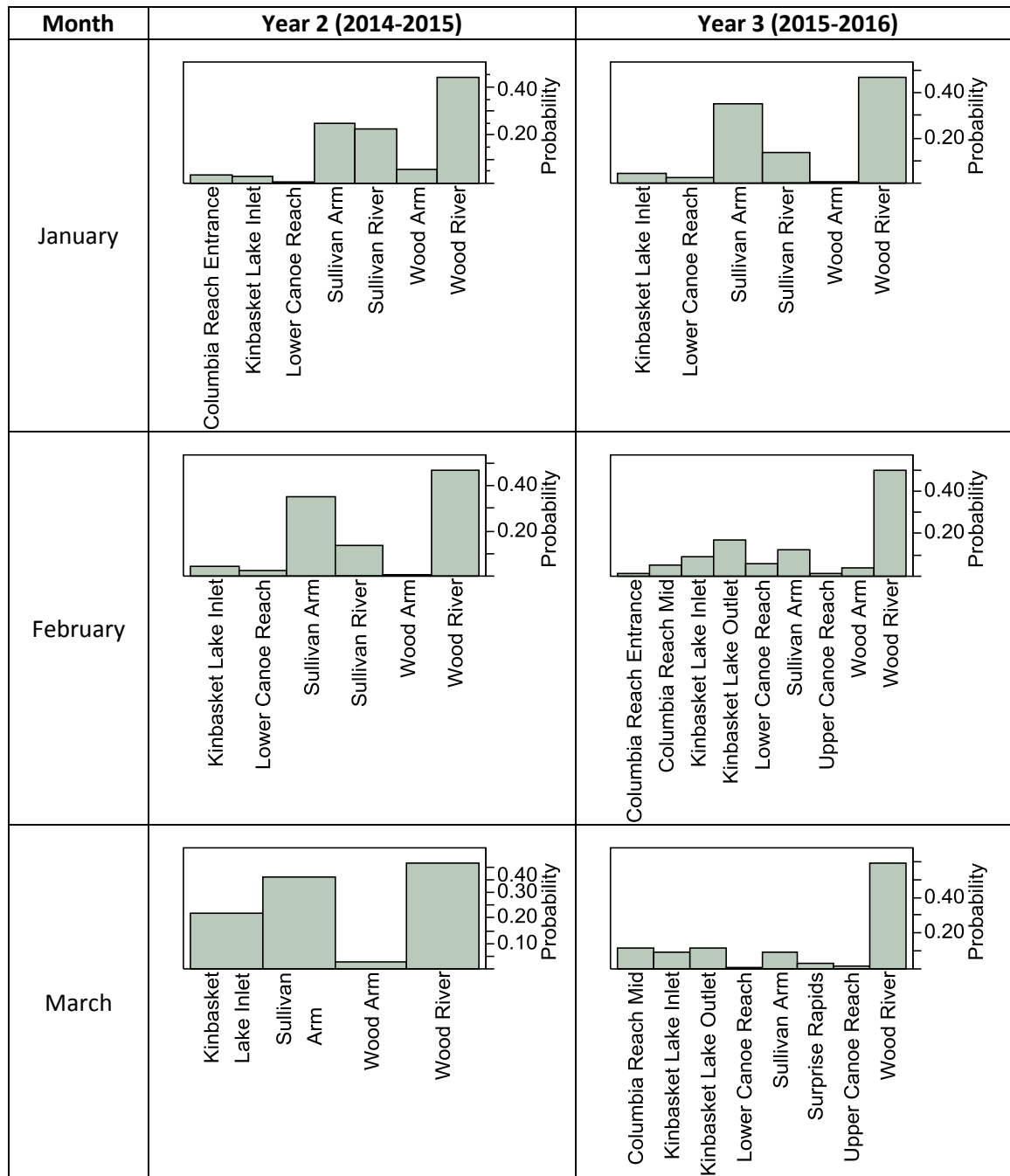
Table 2: Summary of locations of detection for each Burbot (listed left to right according to locations from North to South). Yellow circles = capture location; black checks = 2014-2015 detection; red checks = 2015-2016 detection. Bolded acoustic codes represent Burbot that have not yet been detected during the study.

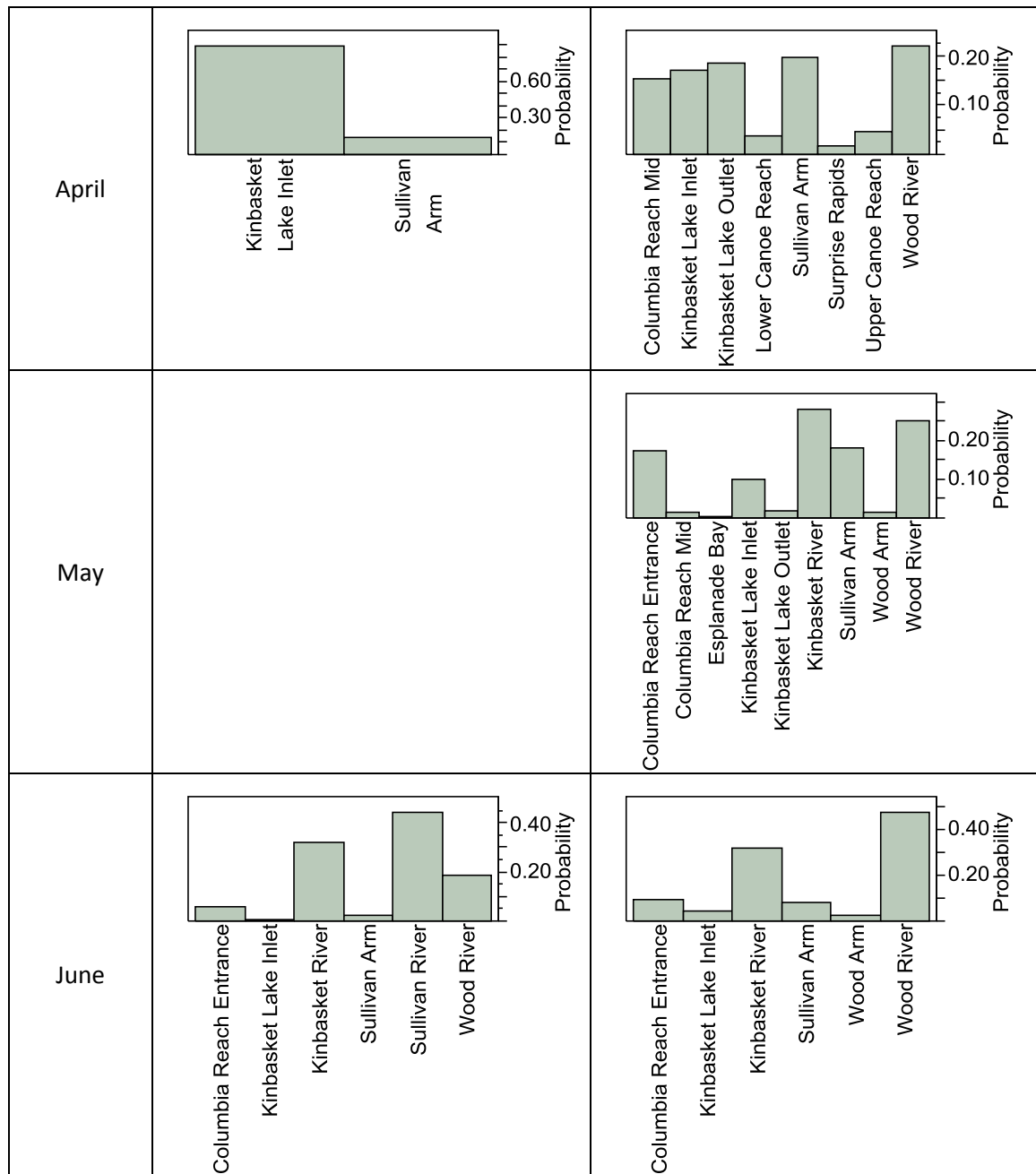
Acoustic Code	Upper Canoe Reach	Lower Canoe Reach	Wood Arm	Wood River	Columbia Reach Entrance	Columbia Reach Mid	Kinbasket Lake	Kinbasket River	Kinbasket Lake	Sullivan Arm	Sullivan River	Surprise Rapids	Bush Arm	Esplanade Bay	Columbia River
<b>2014 IMPLANTS</b>															
29500		✓	●	✓✓				✓							
29600		✓	●✓	✓	✓				✓	✓	✓				
29800		✓	●✓	✓	✓✓		✓	✓	✓✓	✓✓	✓✓				
29900			✓✓	✓✓	✓✓		●								
30100			●✓	✓✓	✓										
30200					✓✓	●✓									
30300							✓	●✓✓		✓✓	✓				
30400								●✓		✓	✓				
30500							✓			●✓✓	✓✓				
30600				✓				●✓		✓					
30700								✓		✓	●✓				
30800								✓		✓	●✓				
30900		✓	✓	✓					✓	✓	●✓				
31000											●✓✓				
31100								●✓	✓	✓	✓				
31200		✓		✓	✓			●✓		✓	✓				
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<b>32300</b>															
32500	✓	✓	●✓	✓✓											
32600			●✓	✓	✓										
<b>32700</b>															
33000					✓	●		✓	✓	✓	✓				
33100								●✓							
33200								✓		✓	●✓				
33300								✓✓		✓✓	●✓				
33400			●✓	✓											
33500	✓		●✓		✓				✓	✓					
33600					●				✓						
33700							✓	●		✓					
33900									✓			●			✓
34000										✓	●✓				
34100					✓	●									

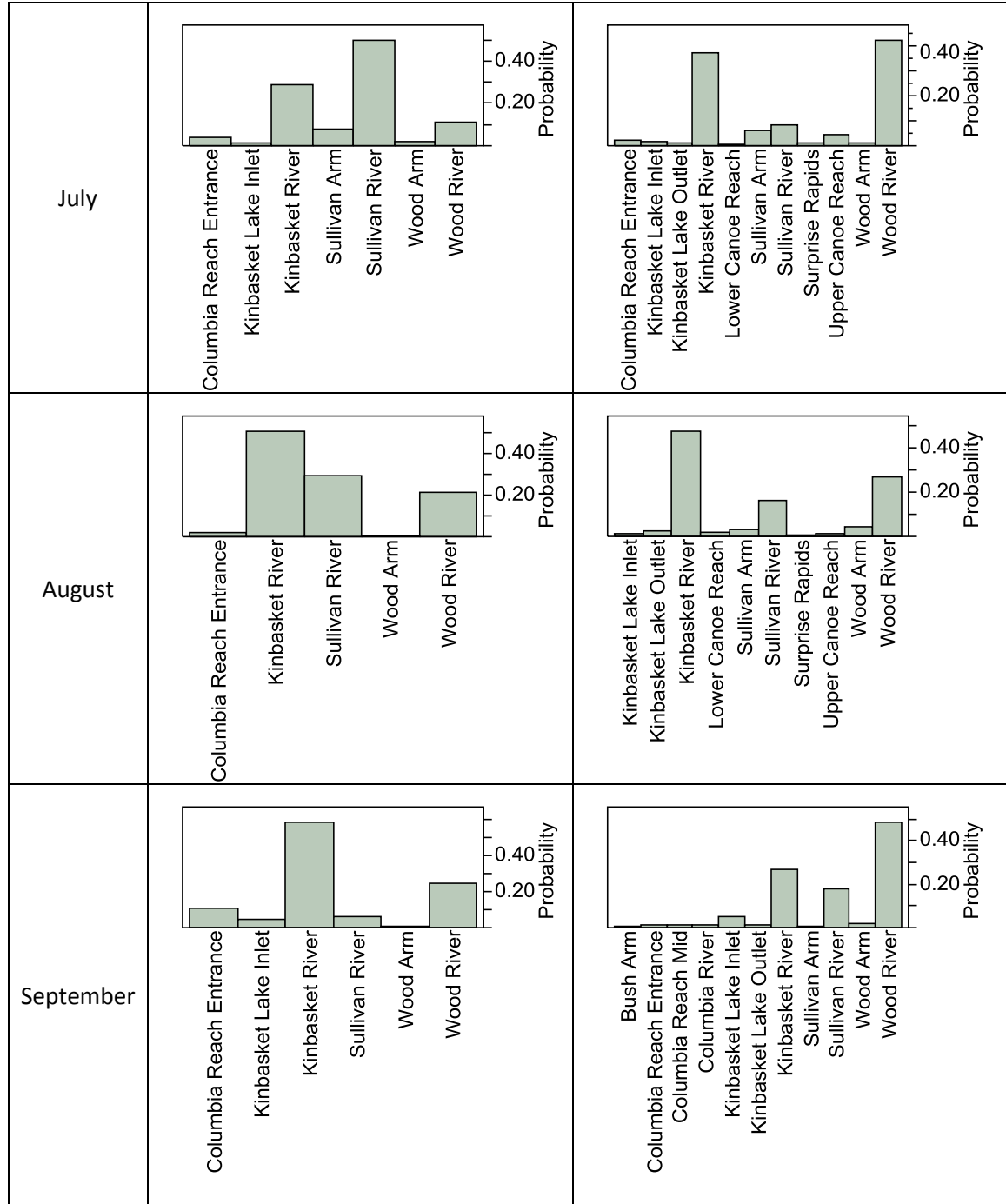


Acoustic Code	Upper Canoe Reach	Lower Canoe Reach	Wood Arm	Wood River	Columbia Reach Entrance	Columbia Reach Mid	Kinbasket Lake	Kinbasket River	Kinbasket Lake	Sullivan Arm	Sullivan River	Surprise Rapids	Bush Arm	Esplanade Bay	Columbia River
34200		✓	•	✓✓											
34300			•	✓			✓		✓	✓					
34400								•✓✓	✓						
34500					✓	•									
<b>2015 IMPLANTS</b>															
34 600									✓	✓	•	✓	✓	✓	
34 700										✓	•✓				
<b>34 800</b>															
<b>34 900</b>															
35 000							✓		✓	•✓	✓	✓			
35 100								✓		•					
35 200							✓	•✓		✓					
35 300							✓	•✓							
35 400									✓		•✓				
35 500									✓		•				
35 600											•✓				
35 700											•✓				
35 800			✓	•✓											
35 900								•✓							
36 000								•✓							
36 100									✓	✓	•✓				
36 200	✓	✓	•✓	✓											
36 300	✓	✓		•✓											
36 400			•	✓											
36 500			✓	•✓	✓										
36 600	✓	✓	•✓	✓											
36 700					✓	•	✓								
36 800			•✓												
36 900			✓	•✓	✓										
<b>37 200</b>															
37 300							✓	•							
<b>37 400</b>															
37 600												•✓			
<b>37 700</b>															
37 800										✓	•				
37 900					•				✓			✓			
<b>38 000</b>															
38 100					•				✓						
38 200										✓	•✓				
38 300									✓	✓	•✓	✓		✓	
38 400							✓			•					
<b>38 600</b>															

Acoustic Code	Upper Canoe Reach	Lower Canoe Reach	Wood Arm	Wood River	Columbia Reach Entrance	Columbia Reach Mid	Kinbasket Lake	Kinbasket River	Kinbasket Lake	Sullivan Arm	Sullivan River	Surprise Rapids	Bush Arm	Esplanade Bay	Columbia River
38 700							●	✓							
<b>38 800</b>															
38 900				●✓											
39 000							✓	●✓	✓	✓	✓				
39 100		✓			●										
39 200			✓	●✓											
39 300	✓	✓	●✓	✓											







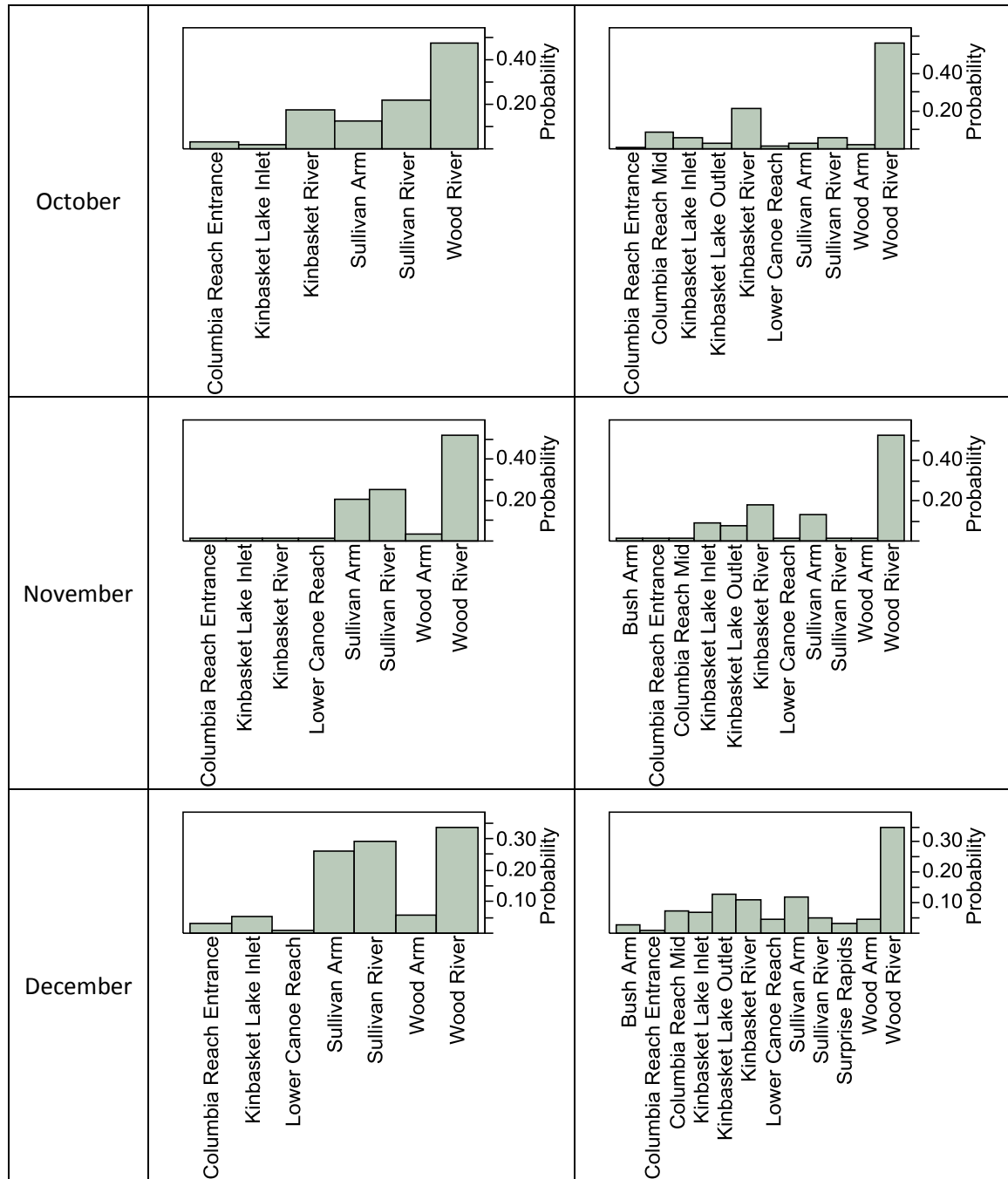


Figure 4: Summary of proportion of monthly detections of Burbot at receiver locations in Kinbasket Reservoir. Note axes are not standardized. No detections were made in May 2015 due to receiver battery failure.

Mean depth of Burbot in Year 2 (2014-2015, including the supplemental information collected from receivers 7, 11, 14, and 16 that were not included in the summary Year 2 report) was  $19.9 \pm 8.20$  m while most Burbot were distributed in the depth range of 15.0 to 24.0 m (Figure 5).

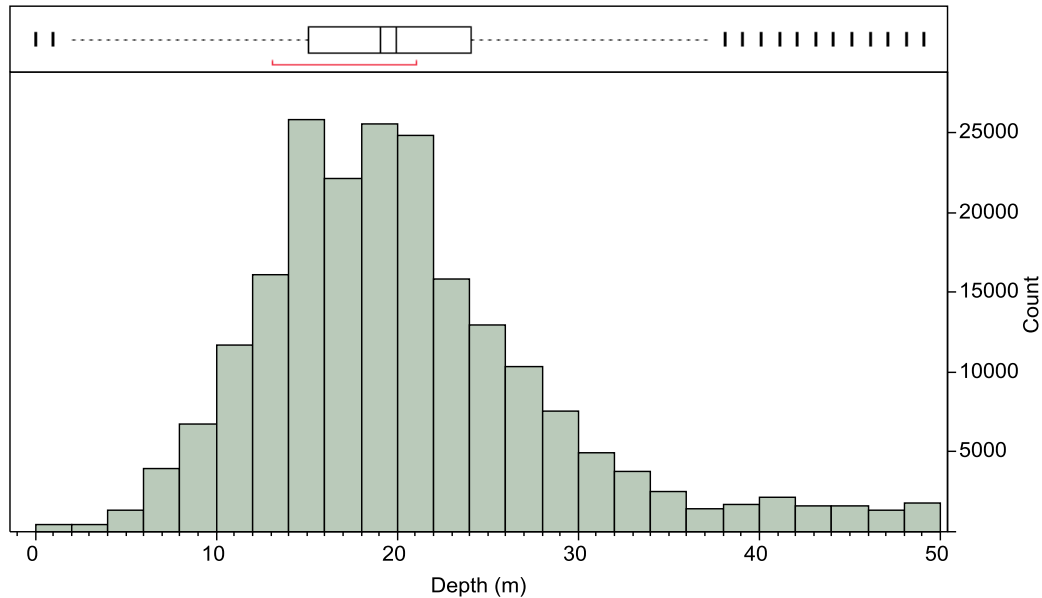


Figure 5: Distribution (histogram and box plot) of depth (m) for Burbot detected by acoustic tracking ( $n = 42$ ) in Kinbasket Reservoir during 2014-2015. Boxes represent interquartile range, diamonds represent the sample mean and 95% confidence interval, while the middle line in the box is the median sample value. Whiskers represent observations outside of the interquartile range, with outlier data points. The red line indicates the densest 50% of the observations.

Mean depth of Burbot in Year 3 (2015-2016, excluding data collected by unrecovered receivers 2, 3, 9, 79, 120, and 123) was  $15.2 \pm 8.94$  m while most Burbot were distributed in the depth range of 9.0 to 20.0 m (Figure 6).



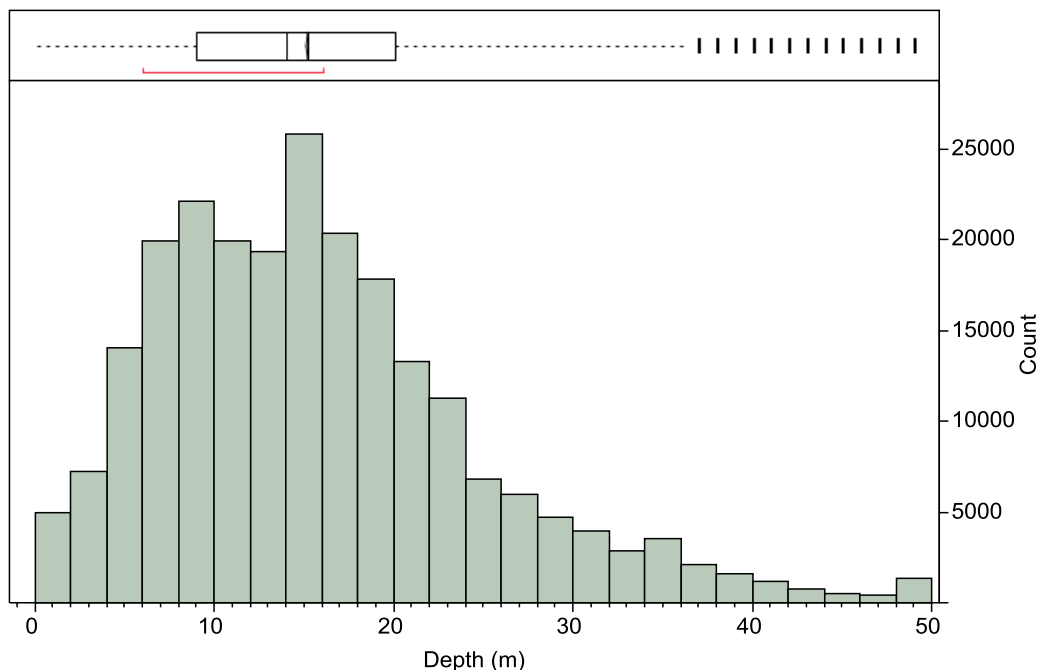


Figure 6: Distribution (histogram and box plot) of depth (m) for Burbot detected by acoustic tracking ( $n = 68$ ) in Kinbasket Reservoir during 2015-2016. Boxes represent interquartile range, diamonds represent the sample mean and 95% confidence interval, while the middle line in the box is the median sample value. Whiskers represent observations outside of the interquartile range, with outlier data points. The red line indicates the densest 50% of the observations.

Depth profiles illustrate the variability in movements among Burbot, with individuals occupying a range of depths (Appendix 3). However, some general trends are apparent such as movements from shallow to deeper areas from June to November-December and subsequent movement to shallower depths from January to April-May (movements are discussed further below). Diel vertical migration (DVM) identified in Year 2 was also observed in Year 3 and is illustrated by the vertical pattern of multiple points within a day.

Of the 72 detected and living Burbot, 31% of individuals appeared to move into areas deeper than the receiver range limit of 50 m, as illustrated by numerous data points along the 50 m mark (Appendix 3). The Burbot with acoustic code 31800 was reported in Year 2 as occupying particularly deep areas (40 - 49 m) for most of the monitoring period until Dec. 19, 2014. However, supplemental data collected in Year 3 suggests that the individual may either be dead or may have expelled its tag given the pattern of detections at the same depth over a number of days with changes in depth likely corresponding with changes in reservoir elevations. Similar patterns of detection were observed for Burbot with acoustic codes 29700, 30000, 32900, 37000, 37200, 37500, and 38500, suggesting the same fate for these individuals (10% of detected Burbot).

Burbot occupied lower elevations on average during the 2014-2015 monitoring period than during the 2015-2016 monitoring period (Figure 7; t-test with unequal variance,  $p < 0.0001$ ;  $df = 375343.8$ ). Depths occupied in both years were shallower than that reported by Harrison et al. (2013; day-time and night-time mean depths  $\pm$  SE were  $37.09 \pm 1.30$  m and  $25.9 \pm 1.52$  m, respectively), which might reflect

general differences in depths of receiver locations between studies. Burbot are known to be benthic (Fischer 2000a, 2000b) and depth detections likely reflect their benthic behaviour.

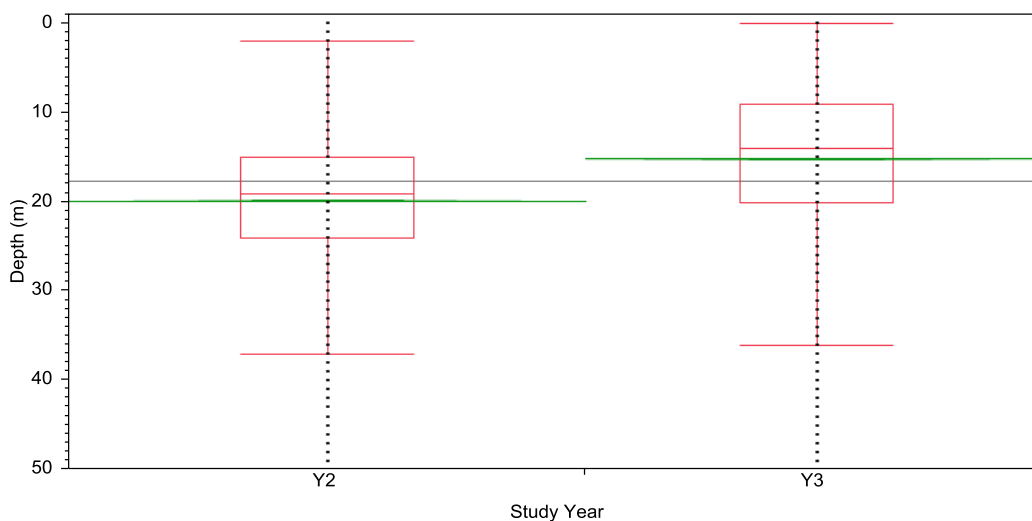


Figure 7: Mean depth (m) of Burbot for each study year (Year 2: 2014-2015 and Year 3:2015-2016). Boxes represent interquartile range with the middle line representing the median sample value. Diamonds represent the 95% confidence interval with the middle line representing the mean. Whiskers represent observations outside of the interquartile range, with outlier data points. Data from June 2014 to May 2016.

Although depths occupied during the 2015-2016 monitoring period were on average generally shallower than those occupied during the 2014-2015 monitoring period, depths occupied during Fall (i.e., September, October, November; mean  $\pm$  SE = 19.41  $\pm$  0.180 m, n=3332) and Winter (i.e., December, January, February; mean  $\pm$  SE = 19.99  $\pm$  0.210, n=2472) were significantly greater than depths occupied during Spring (i.e., March, April, May; mean  $\pm$  SE = 15.30  $\pm$  0.310, n=1134) and Summer (i.e., June, July, August; mean  $\pm$  SE = 14.82  $\pm$  0.210, n=2440; Tukey post-hoc tests all  $p < 0.0001$ , n=9378; Cohen's effect size value  $d = 0.5$  suggests a moderate significance; Figure 8). These trends are consistent with movement from deep areas during Fall-Winter and subsequent movement to shallow areas during the spawning period in Spring-Summer. There was a lack of data from November 2014 to April 2015 due to battery failure and there were noticeably fewer detections in Spring than other seasons. Movement data from all years will be evaluated against elevation data in the Year 4 report.

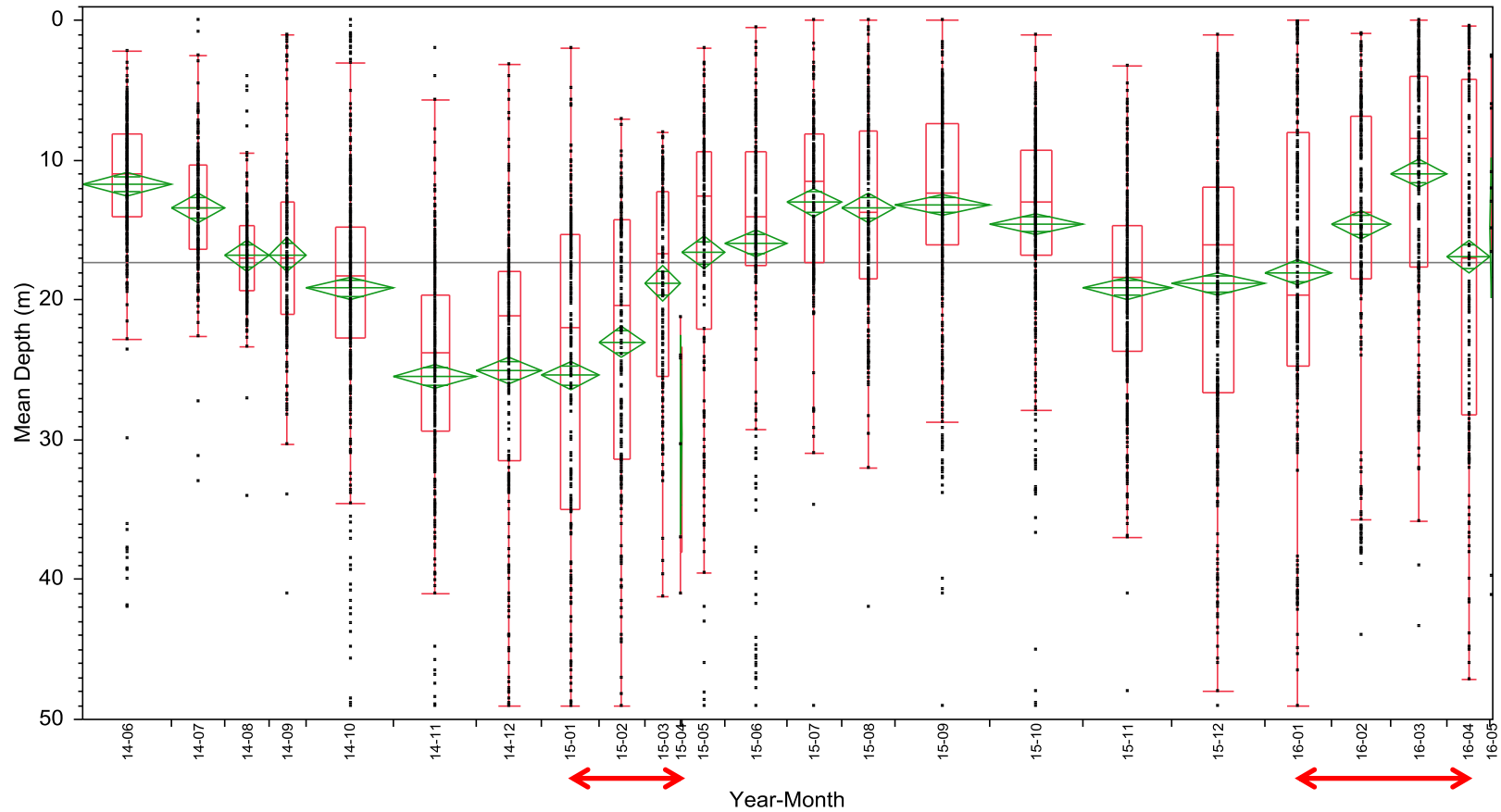


Figure 8: Mean daily depth (m) of Burbot detected each month of the year in all monitoring periods. Boxes represent interquartile range with the middle line representing the median sample value. Diamonds represent the 95% confidence interval with the middle line representing the mean. Whiskers represent observations outside of the interquartile range, with outlier data points. Red double arrows mark the expected spawning periods. Data from June 2014 ('14-06') to May 2016 ('16-05').

## Burbot Mortality

Twelve Burbot were either suspected (n=10) or confirmed dead (n=2) by the end of the second year of study (Table 3), including the five Burbot mortalities reported in the Year 2 report (Kang et al., 2016). The Burbot with acoustic tag 32800 was found by a trapper who found the tag on a rock ledge 1m above the water level on Aug. 23, 2015. Teeth marks (possibly from an otter) on the broken tag indicated that the Burbot had died from predation. The Burbot with acoustic tag 30800 died from harvesting on Jul. 30, 2014 by a fisherman who returned the tag. Data collected in Year 3 indicated 7 additional Burbot have either died or expelled their tags based on repeated patterns of detection at the same depth over a number of days (Table 3).

Table 3: Summary of suspected or confirmed mortality of tagged Burbot in Kinbasket Reservoir.

Acoustic Code	Tag Year	Location tagged	Date mortality determined	Location of mortality	UTM E	UTM N	Cause of mortality	Method used to determine mortality	Mortality Confirmed?
29700	2014	Wood Arm	5-Jun-14	Wood Arm	419541	5780798	Unknown	Depth data	No
30000	2014	Surprise Rapids	25-Jul-15	Surprise Rapids	451616	5737839	Unknown	Depth data	No
30800	2014	Kinbasket River confluence	30-Jul-14	Kinbasket River confluence	436934	5756668	Angler harvest	Angler return of tag	Yes
31500	2014	Sullivan River confluence	22-Mar-15	Mica Dam tailrace	390817	5767174	Entrainment	Sensor data from aerial tracking	No
31800	2014	Columbia Reach	13-Jun-15	Kinbasket Lake inlet	443248	5743798	Unknown	Depth data	No
32400	2014	Columbia Reach south	18-Apr-15	Columbia Reach south; surprise rapids	453133	5735739	Unknown	Sensor data from aerial tracking	No
32800	2015	Kinbasket River confluence	23-Aug-15	Kinbasket River confluence	431480	5757714	Predator	Tag found with teeth marks	Yes
32900	2015	Wood River confluence	15-May-15	Wood River confluence	420315	5782027	Unknown	Depth data	No
37000	2015	Surprise Rapids	25-Jul-15	Surprise Rapids	451724	5737999	Unknown	Depth data	No
37200	2015	Surprise Rapids	25-Jul-15	Surprise Rapids	449108	5739467	Unknown	Depth data	No
37500	2015	Sullivan River confluence	18-May-15	Kinbasket Lake inlet	437063	5756831	Unknown	Depth data	No
38500	2015	Sullivan River confluence	23-Jul-15	Sullivan River	438673	5756887	Unknown	Depth data	No

## DISCUSSION AND RECOMMENDATIONS

### Mobile and fixed receiver tracking

The fixed acoustic tracking information from Year 2 (2014-2015) showed clear seasonal patterns in depth occupation and were corroborated by information collected in Year 3 (2015-2016). Receiver settings were modified in Year 3 so that battery life could be maximized, and the sample sizes of detections in the late winter period (i.e., February to April) supported more robust statistical tests

during this time of year. While data indicated variability in the depths occupied by Burbot, 94% of tagged Burbot (with data recorded during the expected spawning period) occupied relatively shallow areas in Spring-Summer and deeper areas in Fall-Winter (Figure 8 and Appendix 3). The timing in occupation of the shallowest depths (March 2016 mean  $\pm$  SE depth = 10.9  $\pm$  0.51 m) is associated with a generalized time period that could coincide with spawning (Harrison et al., 2013). This may reflect true movement to shallower depths during the spring and summer period for spawning, some other activity, or it may indicate occupation of shallower depths at this time of year due to the reservoir operations. In a concurrent study on Kinbasket Reservoir (CLBMON-6), adult Burbot were captured in nearshore fyke nets set in the Canoe Reach of Kinbasket Reservoir (Kang and Warnock, 2017). This was the first sampling session through a monthly shoreline sampling program which concluded in August, and was the only one in which Burbot were detected. All Burbot that were assumed to be alive during tracking displayed distinct behavioural patterns of diel vertical migration.

Aerial radio tracking conducted from February to April 2015 indicated that Burbot use shallow water habitat during these months in the reservoir, with the greatest number of detections on March 22, 2015 (Kang et al., 2015). There were also several observations of river habitat occupation from radio tracking data during this time period (Kang et al., 2015). These fish were detected at the Sullivan River (identified by local anglers as a historic location for large Burbot capture; Prince, 2001) and made limited movements (<2 km) upriver. It is hypothesized that this behaviour is indicative of a segment of the population that engages in an adfluvial life history, undertaking limited movements up large spawning tributaries. Time of spawning in March is further corroborated by patterns of detection collected from acoustic tracking and observations of 4 ripe fish captured during tagging in April (Kang et al., 2015).

The occurrence of Burbot in shallow areas in June suggests that Burbot may occupy shallow areas during the post-spawn period (Harrison et al., 2013). Incorporation of data from 2016-2017 will provide further elucidation of the distribution, migratory behaviour, and depth use during the spawning season. Information on the depths occupied by Burbot will be used to determine if these depths are at risk of dewatering with reservoir operations.

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APPENDIX 1: Summary of locations of capture/detection and depth statistics for Burbot (n = 72) in Kinbasket Reservoir (capture locations listed from North to South). Depth sensor maximum to 50 m and detections were made to the nearest meter.

Acoustic Code	Radio Code	Frequency	Length (mm)	Weight (kg)	Capture Location	Receivers	Detection Location	Mean Depth (m)	SD Depth (m)	Min Depth (m)	Max Depth (m)
39100	24	150.3	610	0.9	Encampment Creek	124	Lower Canoe Reach	22.8	10.37	15	38
29500	1	150.25	742	1.6	Wood Arm	5, 12, 124	Wood River, Lower Canoe Reach	21.8	7.3	3	45
29600	2	150.25	715	2	Wood Arm	7, 11, 14	Sullivan Arm, Sullivan River, Lower Canoe Reach	21.3	10.85	4	49
29800	4	150.25	770	2.4	Wood Arm	1, 4, 6, 7, 8, 11, 13, 14, 15, 121	Lower Canoe Reach, Columbia Reach Entrance, Kinbasket River, Kinbasket Lake Inlet, Sullivan Arm, Sullivan River	21	8.37	3	49
30100	7	150.25	795	2.5	Wood Arm	5, 10, 12, 13, 15	Columbia Reach Entrance, Wood Arm, Wood River	17.2	7.81	0	41
32500	5	150.3	747	1.8	Wood Arm	5, 12, 124	Lower Canoe Reach, Wood River	16.6	6.28	0	36
32600	6	150.3	660	1.5	Wood Arm	13, 15	Columbia Reach Entrance	15.5	3.78	4	39
33400	14	150.3	570	1	Wood Arm	5, 6, 9, 10, 12	Wood Arm, Wood River, Kinbasket River	21.3	10.28	6	49
33500	15	150.3	656	1.2	Wood Arm	7, 125	Upper Canoe Reach, Sullivan Arm	21.1	8.21	10	49
34200	22	150.3	683	1.4	Wood Arm	5, 12, 14	Lower Canoe	17	6.2	2	30

CLBMON-05: Kinbasket Reservoir Burbot Life History and Habitat Use Assessment

Acoustic Code	Radio Code	Frequency	Length (mm)	Weight (kg)	Capture Location	Receivers	Detection Location	Mean Depth (m)	SD Depth (m)	Min Depth (m)	Max Depth (m)
34300	23	150.3	642	1.4	Wood Arm	8, 113	Reach, Wood River Kinbasket Lake Outlet, Kinbasket Lake Inlet	18.9	5.18	4	37
36200	17	150.27	700	1.72	Wood Arm	5, 10, 12, 124, 125	Upper Canoe Reach, Lower Canoe Reach, Wood Arm, Wood River	13.9	6.15	0	49
36400	19	150.27	723	1.8	Wood Arm	5, 12	Wood River	6.9	1.45	5	9
36600	21	150.27	746	1.66	Wood Arm	5, 10, 12, 124	Lower Canoe Reach, Wood Arm, Wood River	14.7	5.28	5	49
36800	23	150.27	697	1.58	Wood Arm	10	Wood Arm	15.8	1.64	13	21
39300	26	150.3	625	1.26	Wood Arm	5, 10, 12, 124, 125	Upper Canoe Reach, Lower Canoe Reach, Wood Arm, Wood River	19.7	6.86	7	49
35800	13	150.27	770	2.06	Wood River	5, 10, 12	Wood Arm, Wood River	8.9	4.26	0	38
36300	18	150.27	804	2.41	Wood River	5, 12, 124, 125	Upper Canoe Reach, Lower Canoe Reach, Wood River	14.2	5.93	3	33
36500	20	150.27	776	1.96	Wood River	5, 10, 12, 13	Wood Arm, Wood River, Columbia Reach	14	5.54	2	49
36900	24	150.27	715	1.86	Wood River	5, 10, 12, 13, 15	Entrance Wood Arm, Wood River, Columbia	14.7	4.3	3	21

CLBMON-05: Kinbasket Reservoir Burbot Life History and Habitat Use Assessment

Acoustic Code	Radio Code	Frequency	Length (mm)	Weight (kg)	Capture Location	Receivers	Detection Location	Mean Depth (m)	SD Depth (m)	Min Depth (m)	Max Depth (m)
38900	22	150.3	697	1.36	Wood River	5, 12	Reach Entrance Wood River	12.1	6.17	0	25
39200	25	150.3	600	1.18	Wood River	5, 10, 12	Wood Arm, Wood River	16.6	6.26	0	32
33600	16	150.3	574	1.1	Columbia Reach	8	Kinbasket Lake Inlet	29.5	5.99	14	49
37900	18	150.3	790	2.41	Columbia Reach	8, 115	Kinbasket Lake Inlet, Surprise Rapids	11.5	4.57	6	18
38100	2	150.3	595	1.08	Columbia Reach	8	Kinbasket Lake Inlet	14.5	9.56	0	46
36700	22	150.27	736	1.81	Cummins Creek	13, 15, 113	Columbia Reach Entrance, Kinbasket Lake Outlet	27.9	17.47	0	49
34100	21	150.3	685	1.3	Cummins River	13, 15	Columbia Reach Entrance	14.6	9.37	0	34
34500	25	150.3	592	0.9	Cummins River	15	Columbia Reach Entrance	26		26	26
29900	5	150.25	904	3.4	Goosegrass Creek (across from Cummins River)	10, 12, 13	Wood Arm, Wood River, Columbia Reach Entrance	16.3	6.01	0	32
30200	8	150.25	642	1.5	Goosegrass Creek (across from Cummins River)	13, 15, 112	Columbia Reach Entrance, Columbia Reach Mid	8.4	5.43	0	39
33000	10	150.3	810	2.7	Goosegrass Creek (across from Cummins River)	7, 11	Sullivan Arm, Sullivan River	25.4	13.32	0	49
38700	20	150.3	667	1.26	Kinbasket Lake Outlet	6	Kinbasket River	34	14.89	10	46
30300	9	150.25	720	1.8	Kinbasket River	1, 6, 7, 11, 113	Kinbasket Lake Outlet, Kinbasket River, Sullivan Arm, Sullivan River	28.4	10.32	5	49
30400	10	150.25	668	1.6	Kinbasket River	7, 11	Sullivan Arm, Sullivan River	12.6	2.79	4	41
30600	12	150.25	655	1.5	Kinbasket	7	Sullivan	16.9	7.17	0	49

CLBMON-05: Kinbasket Reservoir Burbot Life History and Habitat Use Assessment

Acoustic Code	Radio Code	Frequency	Length (mm)	Weight (kg)	Capture Location	Receivers	Detection Location	Mean Depth (m)	SD Depth (m)	Min Depth (m)	Max Depth (m)
31100	17	150.25	950	4.6	River Kinbasket River	7, 8, 11	Arm Kinbasket Lake Inlet, Sullivan Arm, Sullivan River	19.2	5.74	0	49
31200	18	150.25	710	1.9	Kinbasket River	7, 11, 13, 15, 124	Lower Canoe Reach, Columbia Reach Entrance, Sullivan Arm, Sullivan River	16.9	7.25	1	45
33100	11	150.3		1.1	Kinbasket River	6	Kinbasket River	16.9	3.5	6	25
33700	7	150.3	645	1.24	Kinbasket River	4, 113	Kinbasket Lake Outlet, Sullivan Arm	38.9	5.3	27	42
34400	24	150.3	592	1	Kinbasket River	6, 8	Kinbasket River, Kinbasket Lake Inlet	16.6	6.17	0	47
35200	7	150.27	739	1.62	Kinbasket River	1, 4, 6, 113, 122	Kinbasket Lake Outlet, Kinbasket River, Sullivan Arm, Sullivan River	23.1	7.24	4	49
35300	8	150.27	859	2.66	Kinbasket River	6, 113	Kinbasket Lake Outlet, Kinbasket River	18.3	8.61	2	49
35900	14	150.27	864	3.06	Kinbasket River	6	Kinbasket River	16.1	5.99	3	28
36000	15	150.27	788	2.26	Kinbasket River	6	Kinbasket River	9	4.67	0	23
37300	12	150.3	756	1.86	Kinbasket River	113	Kinbasket Lake Outlet	2.1	3.4	0	14
39000	23	150.3	587	1.28	Kinbasket River	1, 4, 6, 8, 113, 121, 122	Kinbasket Lake Outlet, Kinbasket River, Kinbasket Lake Inlet, Sullivan Arm, Sullivan River	15.1	10.97	0	49
30500	11	150.25	735	2	Sullivan	1, 4, 7,	Kinbasket	18.1	7.31	0	49

## CLBMON-05: Kinbasket Reservoir Burbot Life History and Habitat Use Assessment

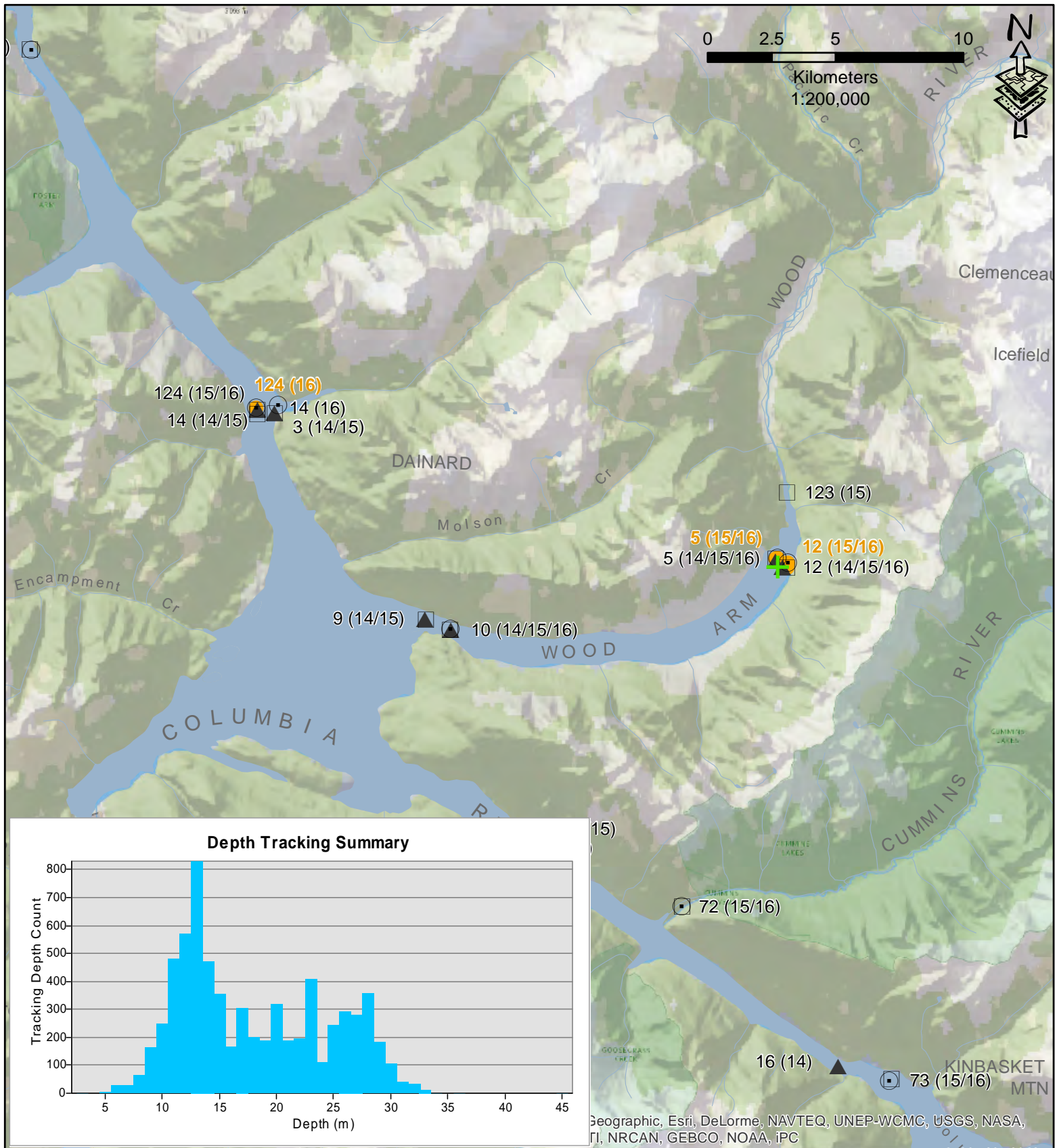
Acoustic Code	Radio Code	Frequency	Length (mm)	Weight (kg)	Capture Location	Receivers	Detection Location	Mean Depth (m)	SD Depth (m)	Min Depth (m)	Max Depth (m)
					River	11, 113, 121, 122	Lake Outlet, Sullivan Arm, Sullivan River				
30700	13	150.25	742	1.8	Sullivan River	7, 11	Sullivan Arm, Sullivan River	18.8	1.81	4	26
30900	15	150.25	768	2.4	Sullivan River	5, 7, 10, 11, 12, 124	Lower Canoe Reach, Wood Arm, Wood River, Sullivan River	24.3	11.4	0	49
31000	16	150.25	794	2.25	Sullivan River	11, 12	Wood River, Sullivan River	5.9	2.8	3	47
31300	19	150.25	731	2.1	Sullivan River	1, 4, 6, 7, 11	Kinbasket River, Sullivan Arm, Sullivan River	26.8	13.54	4	49
31400	20	150.25	744	2.1	Sullivan River	7, 11	Sullivan Arm, Sullivan River	17.2	5.63	5	49
31600	22	150.25	784	2.4	Sullivan River	11	Sullivan River	10.1	2.35	5	21
31700	23	150.25	674	1.6	Sullivan River	11	Sullivan River	14	3.67	9	44
33200	12	150.3	647	1.4	Sullivan River	7, 11	Sullivan Arm, Sullivan River	20.6	6.58	4	36
33300	13	150.3	653	1.3	Sullivan River	1, 4, 6, 7, 11	Kinbasket River, Sullivan Arm, Sullivan River	22.7	6.86	3	49
34000	20	150.3	665	1.4	Sullivan River	7, 11	Sullivan Arm, Sullivan River	15.3	4.67	3	29
34600	1	150.3	723	1.9	Sullivan River	1, 4, 8, 114, 115, 116, 118, 122	Kinbasket Lake Inlet, Sullivan Arm, Surprise Rapids, Bush Arm, Esplanade Bay	16.9	10.28	2	41
34700	2	150.27	715	1.6	Sullivan	1, 4, 121,	Sullivan	5.1	4.39	0	32

CLBMON-05: Kinbasket Reservoir Burbot Life History and Habitat Use Assessment

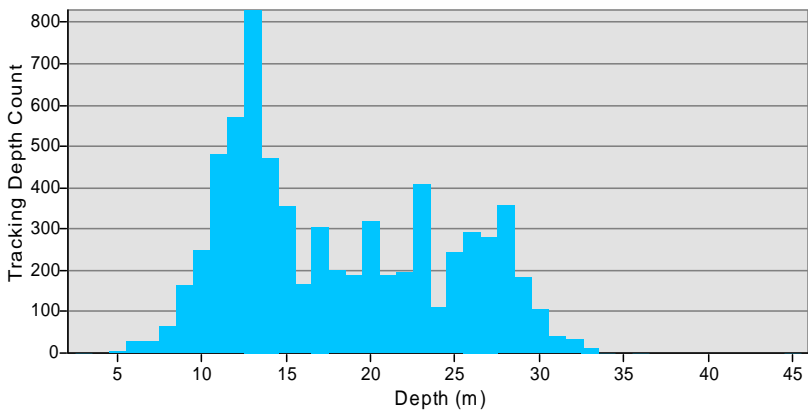
Acoustic Code	Radio Code	Frequency	Length (mm)	Weight (kg)	Capture Location	Receivers	Detection Location	Mean Depth (m)	SD Depth (m)	Min Depth (m)	Max Depth (m)
					River	122	Arm, Sullivan River				
35400	9	150.27	700	1.7	Sullivan River	1, 4, 5, 121, 122	Wood River, Sullivan Arm, Sullivan River	9.1	5.19	0	32
35500	10	150.27	760	1.91	Sullivan River	1, 4	Sullivan Arm	11.2	5.81	7	24
35600	11	150.27	760	1.96	Sullivan River	121	Sullivan River	6.8	1.3	0	10
35700	12	150.27	939	3.96	Sullivan River	121	Sullivan River	6.4	1.8	0	10
36100	16	150.27	792	2.24	Sullivan River	1, 4, 8, 121	Kinbasket Lake Inlet, Sullivan Arm, Sullivan River	6.6	2.94	2	23
37800	17	150.3	727	1.6	Sullivan River	4	Sullivan Arm	18		18	18
38200	3	150.3	650	1.04	Sullivan River	4, 121	Sullivan Arm, Sullivan River	7.6	2.51	4	20
38300	4	150.3	669	1.3	Sullivan River	1, 4, 8, 114, 115, 118, 121, 122	Kinbasket Lake Inlet, Sullivan Arm, Sullivan River, Surprise Rapids, Esplanade Bay	18.8	9.01	2	35
35000	5	150.27	893	2.96	Windy Creek	1, 4, 8, 113, 115, 121, 122	Kinbasket Lake Outlet, Kinbasket Lake Inlet, Sullivan Arm, Sullivan River, Surprise Rapids	16.1	9.15	0	47
35100	6	150.27	713	1.73	Windy Creek	6	Kinbasket River	1		1	1
38400	5	150.3	588	0.84	Windy Creek	113	Kinbasket Lake Outlet	32.7	12.75	20	49
33900	19	150.3	620	1.3	Surprise Rapids	117	Columbia River	22.1	12.63	0	45
37600	15	150.3	818	2.7	Surprise Rapids	114	Surprise Rapids	0	0	0	0



APPENDIX 2: Maps of Year 3 Burbot detection by fixed receivers (n = 24; comprises 20 receivers with 2015-2016 data and 4 receivers with 2014 -2015 data) in the Kinbasket Reservoir study area.



**Depth Tracking Summary**



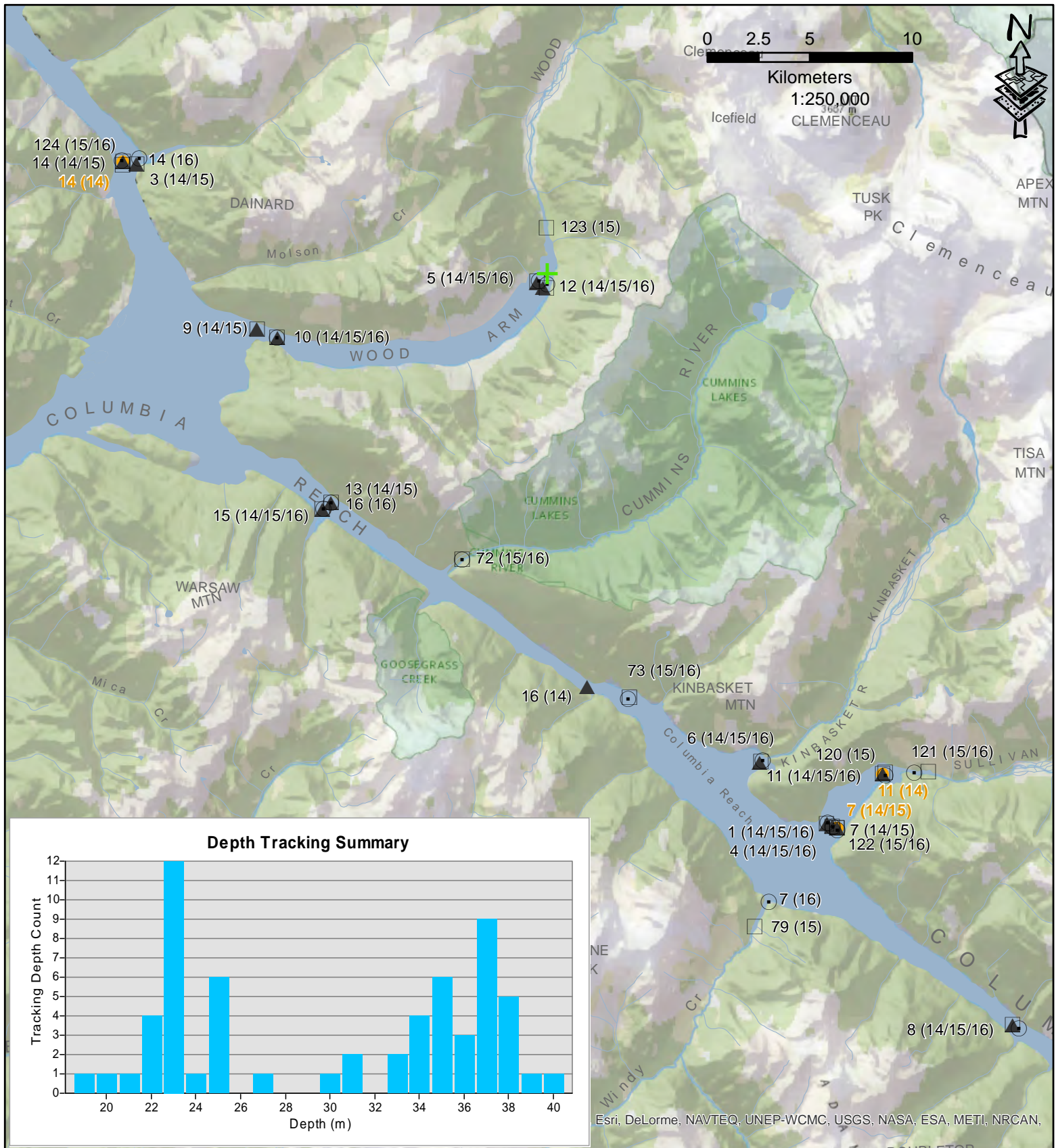
Geographic, Esri, DeLorme, NAVTEQ, UNEP-WCMC, USGS, NASA, FI, NRCAN, GEBCO, NOAA, IPC

- Receiver - Tracking Location (Year)
- ✚ Capture Location
- Receiver Location (Year)
- ▲ 2014
- 2015
- 2016

**Kinbasket Reservoir Burbot Tracking  
Acoustic Code: 29500**

Receiver ID	05	12	124
Tracking Count	2666	4202	2
Tracking Date Range	14/05/2015 to 04/03/2016	14/05/2015 to 13/03/2016	25/04/2016 to 26/04/2016
Depth Range	5m - 32m	3m - 34m	36m - 45m
Average Depth	17.7m	18.2m	40.5m



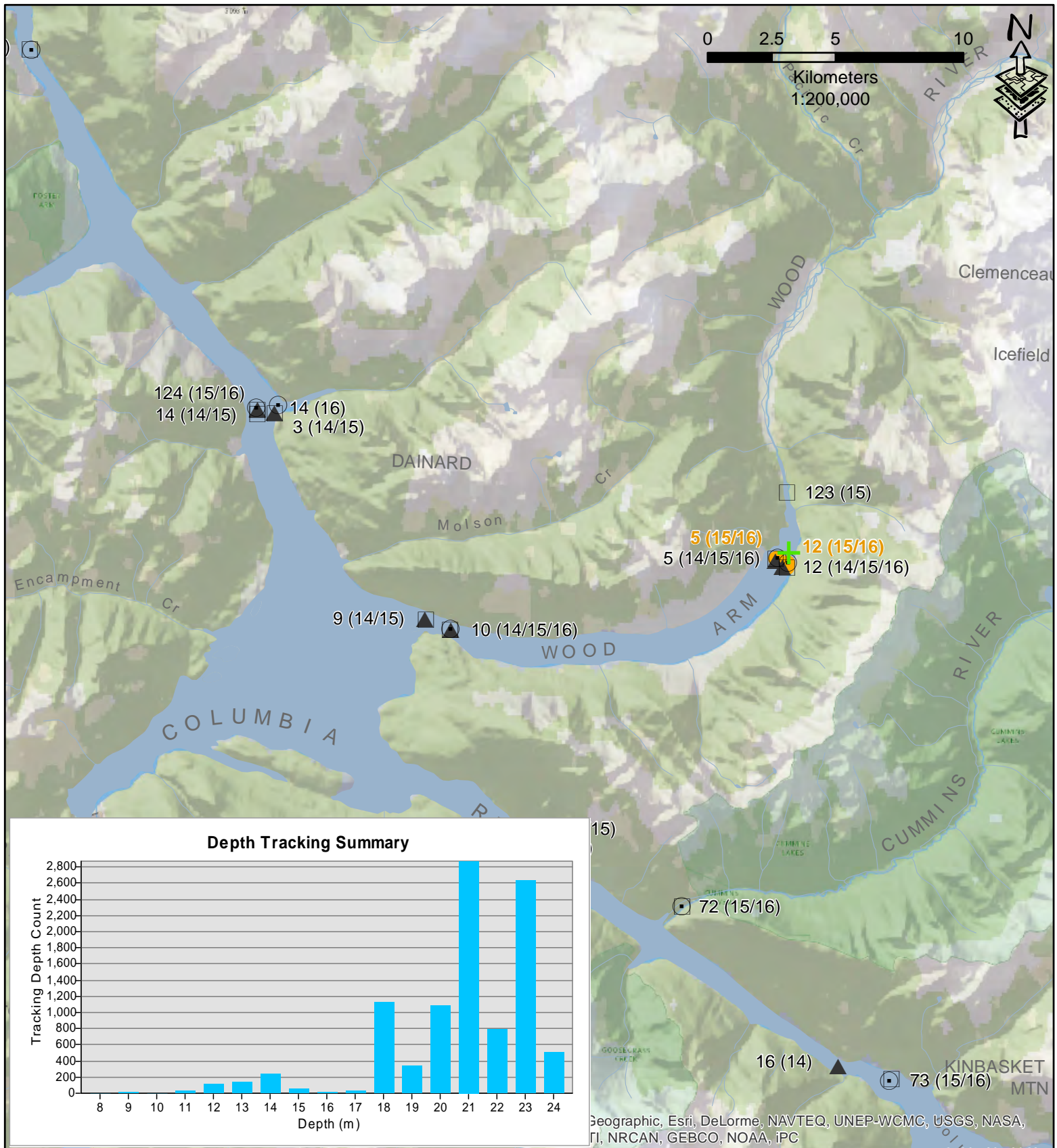


- Receiver - Tracking Location (Year)
- ✚ Capture Location
- ▲ Receiver Location (Year)
- ▲ 2014
- 2015
- 2016

**Kinbasket Reservoir Burbot Tracking  
Acoustic Code: 29600**

Receiver ID	7	11	14
Tracking Count	11	1	49
Tracking Date Range	16/12/2014 to 27/01/2015	17/12/2014 to 17/12/2014	23/11/2014 to 12/12/2014
Depth Range	20m - 30m	19m - 19m	22m - 40m
Average Depth	24.5m	19.m	31.7m



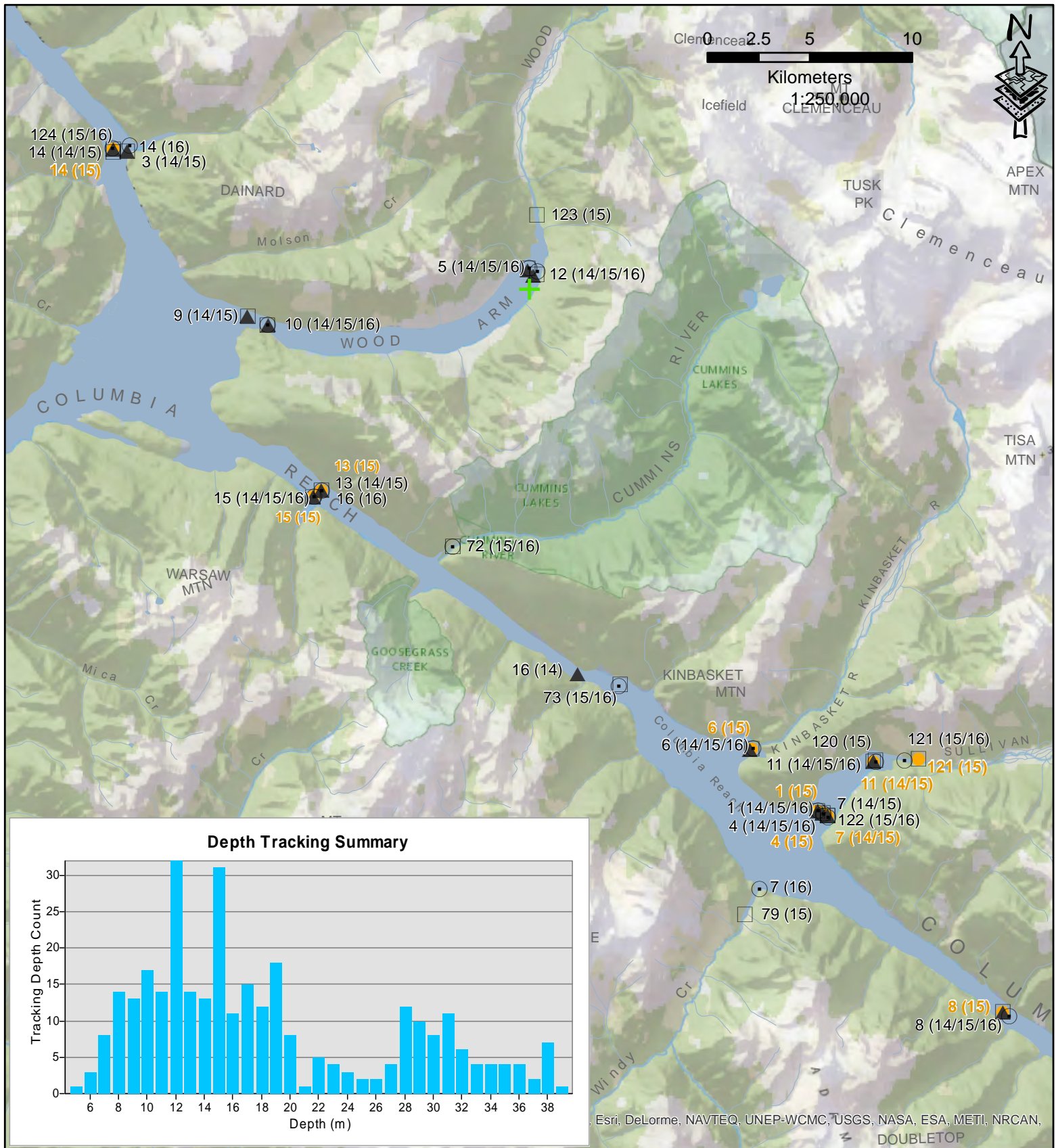


### Kinbasket Reservoir Burbot Tracking Acoustic Code: 29700

- Receiver - Tracking Location (Year)
  - ▲ 2014
  - 2015
  - 2016
- + Capture Location

<b>Receiver ID</b>	5	12
<b>Tracking Count</b>	180	9810
<b>Tracking Date Range</b>	14/05/2015 to 23/04/2016	13/05/2015 to 20/03/2016
<b>Depth Range</b>	9m - 24m	8m - 24m
<b>Average Depth</b>	20.9m	20.8m



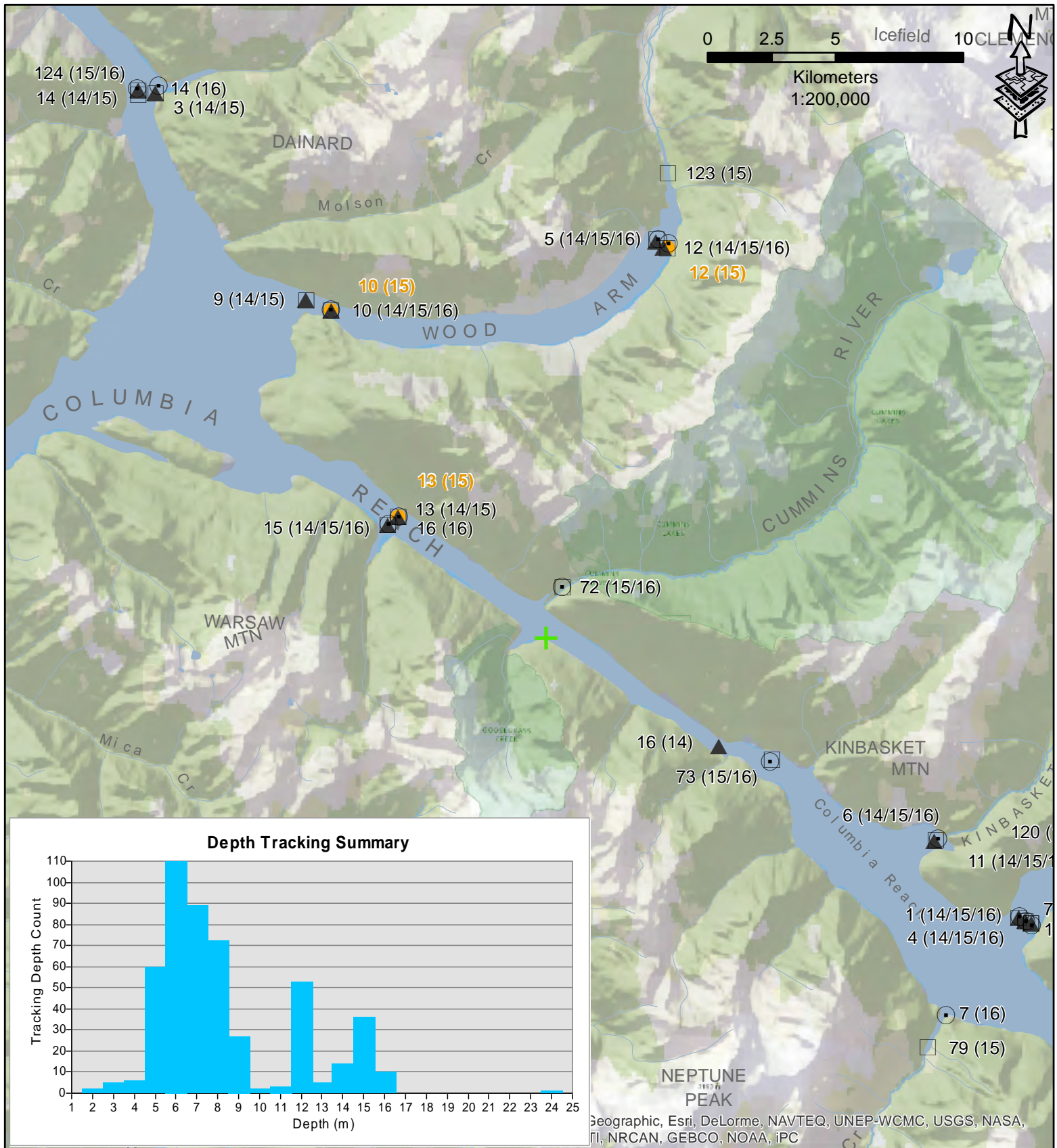


- Receiver - Tracking Location (Year)
- ▲ 2014
- + Capture Location
- 2015
- 2016

**Kinbasket Reservoir Burbot Tracking**  
Acoustic Code: 29800

Receiver ID	1	4	6	7	8	11	121	13	14	15
Tracking Count	11	16	3	50	11	111	51	17	23	25
Tracking Date Range	12/06/2015 to 13/06/2015	13/06/2015 to 13/06/2015	12/06/2015 to 12/06/2015	06/11/2014 to 27/01/2015	20/05/2015 to 09/06/2015	27/11/2014 to 26/01/2015	22/07/2015 to 30/09/2015	17/05/2015 to 04/06/2015	12/02/2015 to 13/02/2015	17/05/2015 to 04/06/2015
Depth Range	6m - 16m	7m - 15m	12m - 17m	10m - 34m	9m - 38m	11m - 34m	5m - 20m	11m - 38m	10m - 26m	10m - 39m
Average Depth	12.m	11.9m	15.m	18.4m	21.5m	19.9m	9.3m	30.5m	15.2m	30.2m





● Receiver - Tracking Location (Year)

⊕ Capture Location

Receiver Location (Year)

▲ 2014

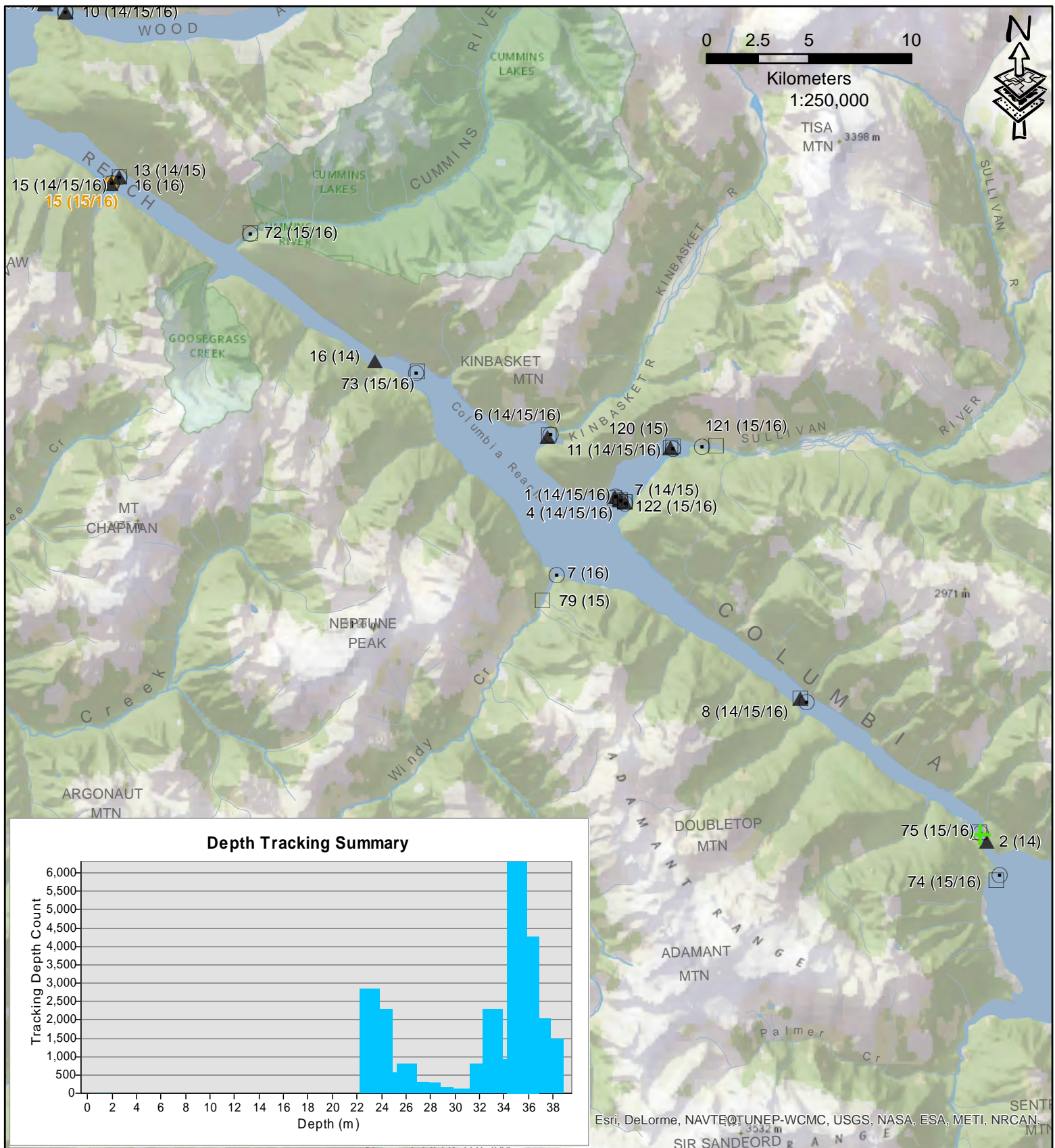
□ 2015

○ 2016

### Kinbasket Reservoir Burbot Tracking Acoustic Code: 29900

Receiver ID	10	12	13
Tracking Count	442	1	52
Tracking Date Range	25/05/2015 to 06/06/2015	02/11/2015 to 02/11/2015	11/05/2015 to 15/05/2015
Depth Range	2m - 16m	24m - 24m	2m - 16m
Average Depth	8.5m	24.m	6.1m



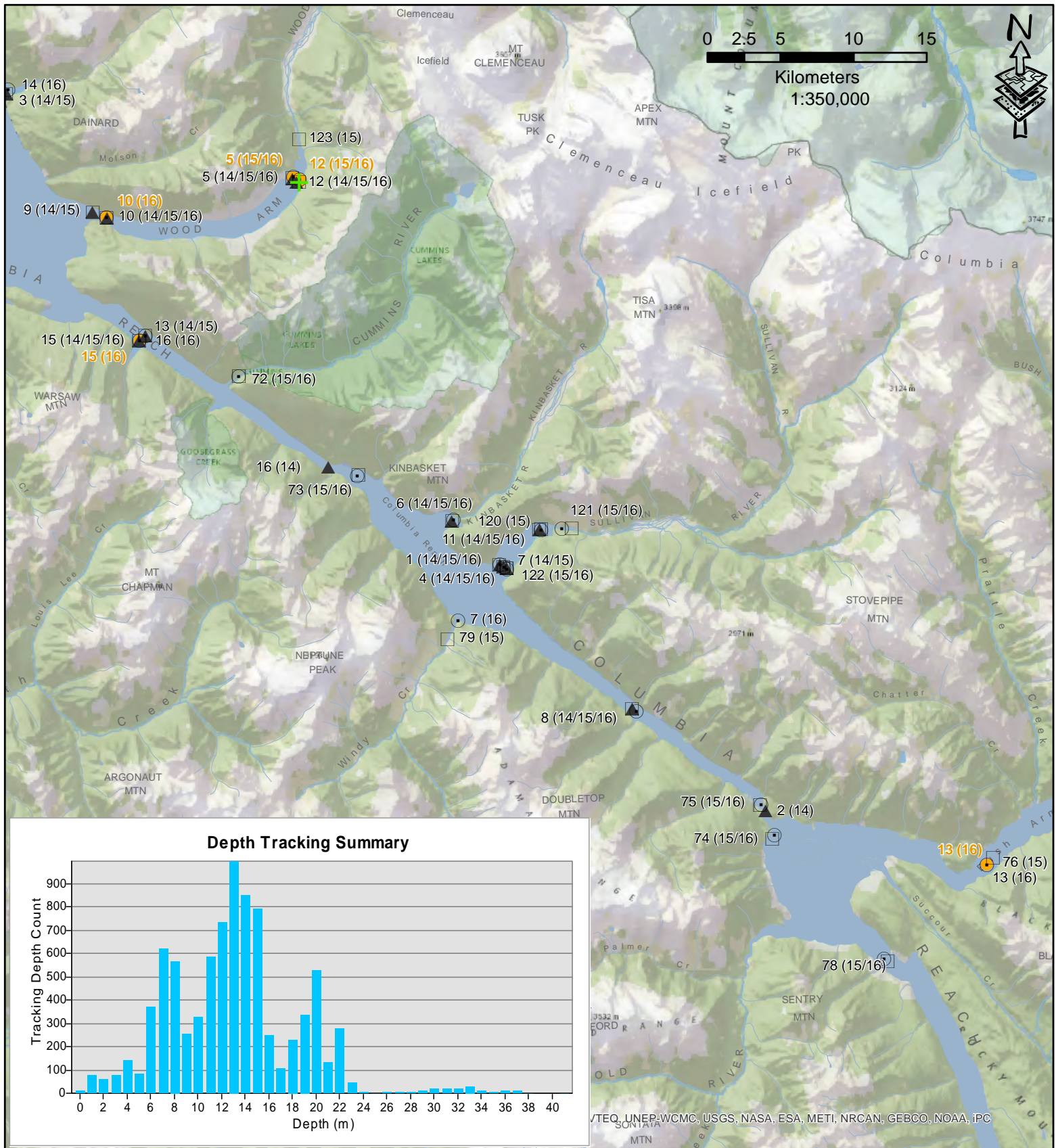


### Kinbasket Reservoir Burbot Tracking Acoustic Code: 30000

- Receiver - Tracking Location (Year)
- ▲ 2014
- ⊕ Capture Location
- 2015
- ⊙ 2016

Receiver ID	115
Tracking Count	25607
Tracking Date Range	25/07/2015 to 06/05/2016
Depth Range	1m - 38m
Average Depth	32.1m



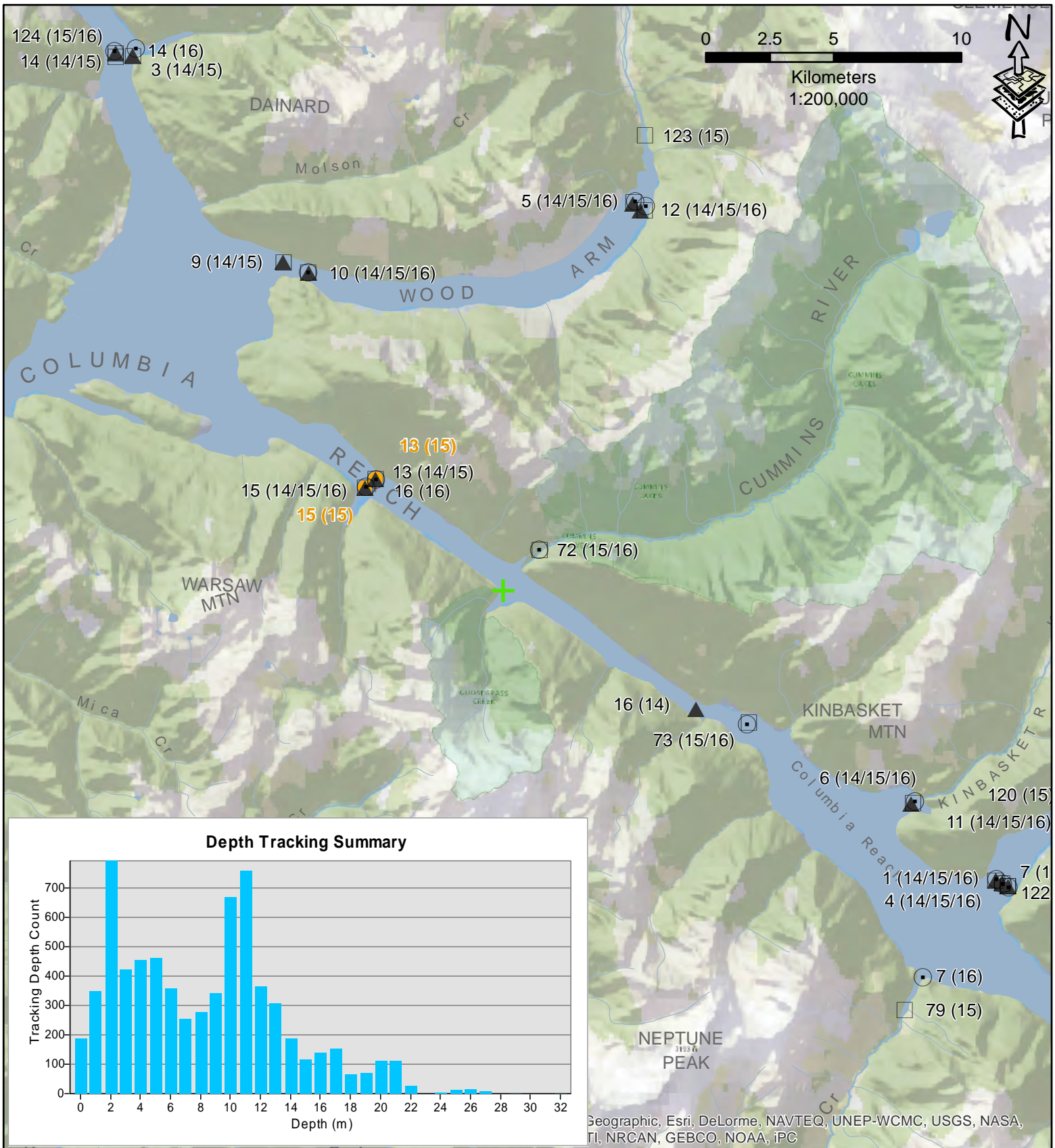


- Receiver - Tracking Location (Year)
- ⊕ Capture Location
- Receiver Location (Year)
- ▲ 2014
- 2015
- 2016

### Kinbasket Reservoir Burbot Tracking Acoustic Code: 30100

Receiver ID	5	10	12	13	15
<b>Tracking Count</b>	4683	58	3853	9	8
<b>Tracking Date Range</b>	14/05/2015 to 17/04/2016	10/02/2016 to 12/02/2016	13/05/2015 to 20/03/2016	18/02/2016 to 19/02/2016	18/02/2016 to 19/02/2016
<b>Depth Range</b>	0m - 32m	29m - 41m	2m - 34m	35m - 37m	35m - 37m
<b>Average Depth</b>	11.6m	33.6m	14.3m	36.2m	36.1m





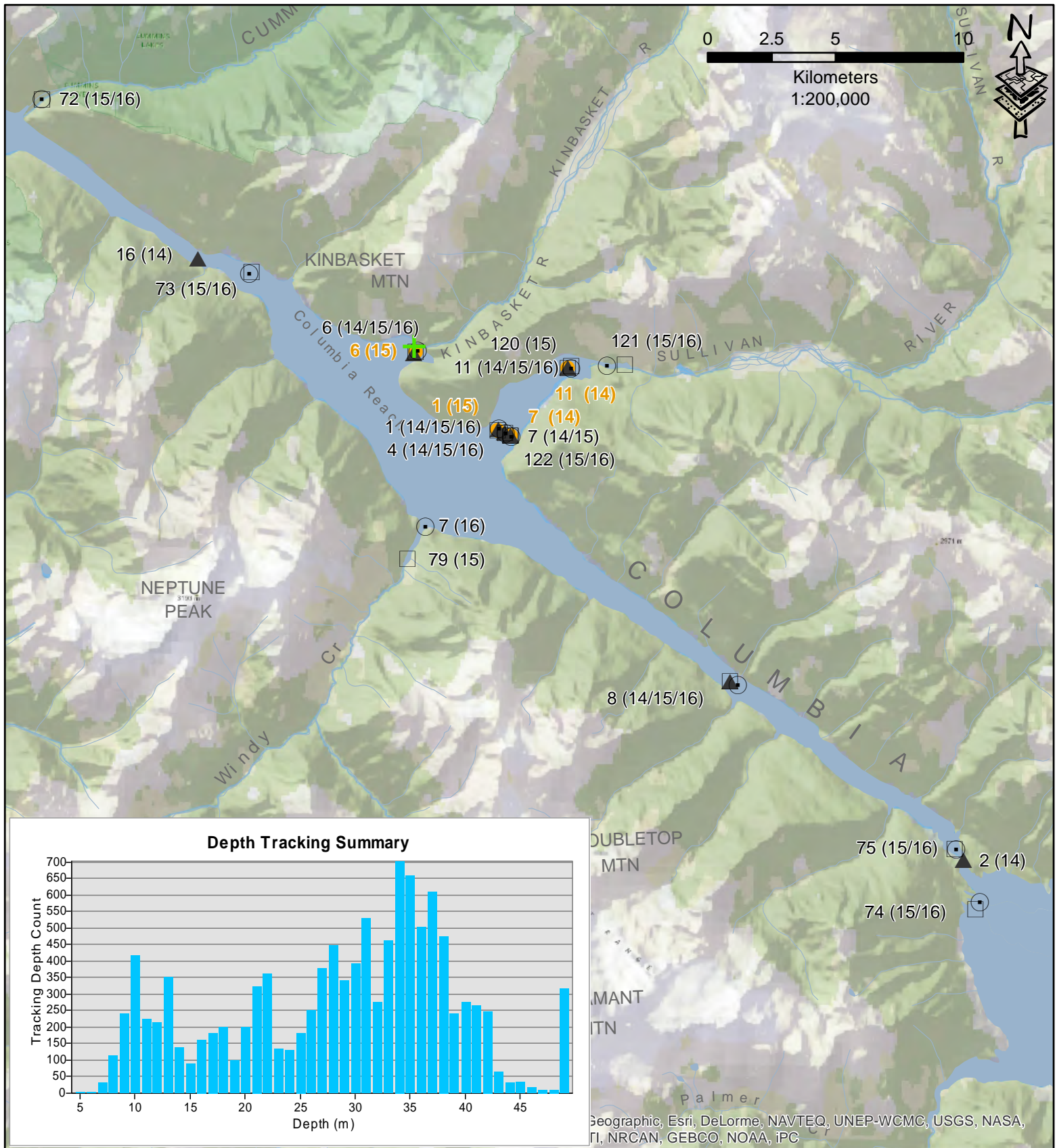
### Kinbasket Reservoir Burbot Tracking Acoustic Code: 30200

- Receiver - Tracking Location (Year)
- ▲ 2014
- ⬜ 2015
- ⊙ 2016
- + Capture Location

Receiver ID	112	13	15
Tracking Count	6886	62	72
Tracking Date Range	25/09/2015 to 02/05/2016	24/09/2015 to 02/12/2015	30/06/2015 to 02/12/2015
Depth Range	0m - 29m	3m - 32m	3m - 27m
Average Depth	8.1m	10.7m	14.6m

Note: Missing location of receiver 112





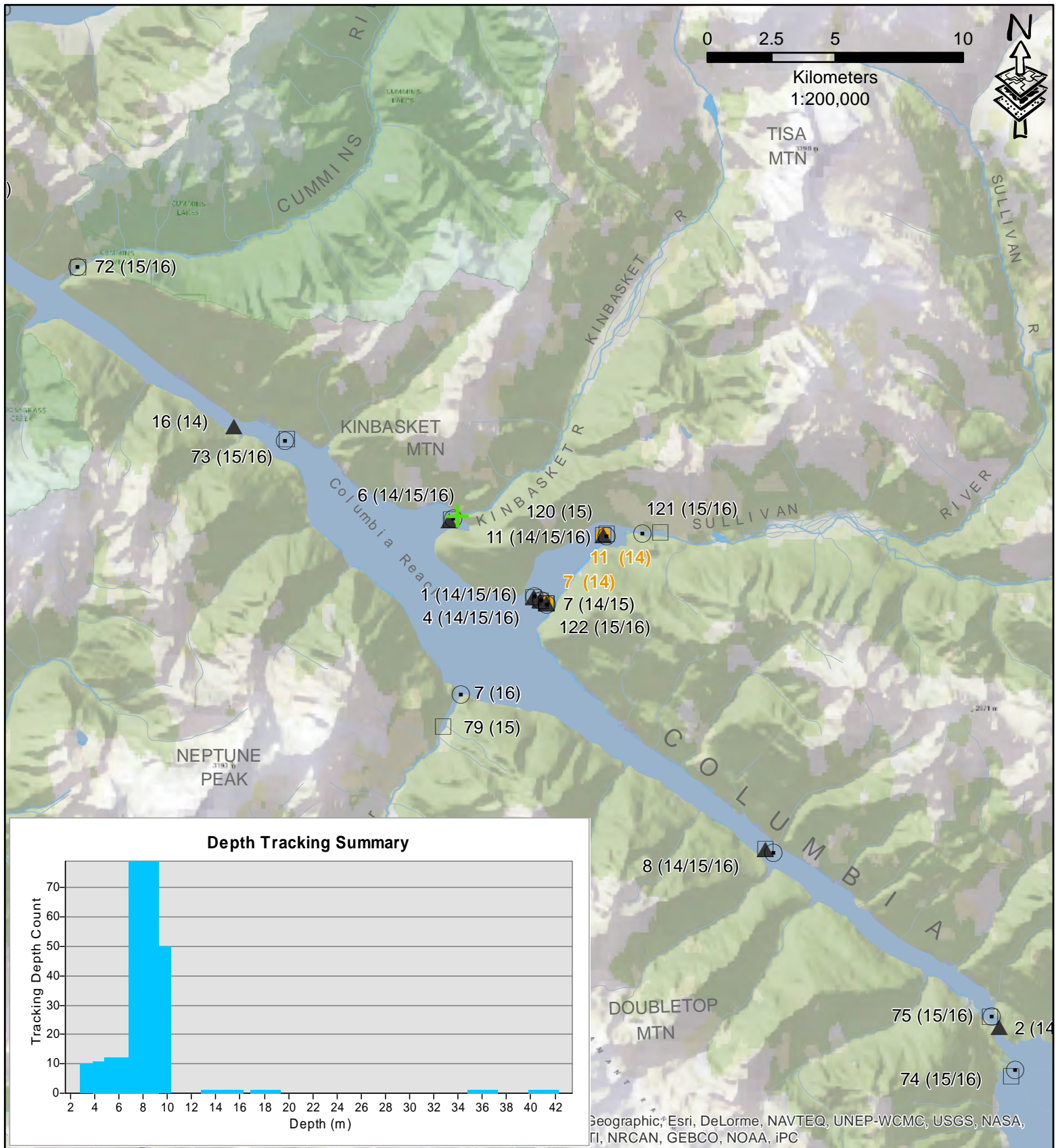
### Kinbasket Reservoir Burbot Tracking Acoustic Code: 30300

- Receiver - Tracking Location (Year)
- ▲ 2014
- + Capture Location
- 2015
- 2016

Receiver ID	1	6	7	11	113
Tracking Count	8	4122	31	45	7117
Tracking Date Range	18/07/2015 to 19/07/2015	20/05/2015 to 12/10/2015	23/11/2014 to 24/11/2014	23/11/2014 to 24/11/2014	12/10/2015 to 24/04/2016
Depth Range	10m - 37m	6m - 41m	12m - 15m	12m - 19m	5m - 49m
Average Depth	17.8m	26.5m	13.5m	13.6m	29.8m

Note: Missing location of receiver 113



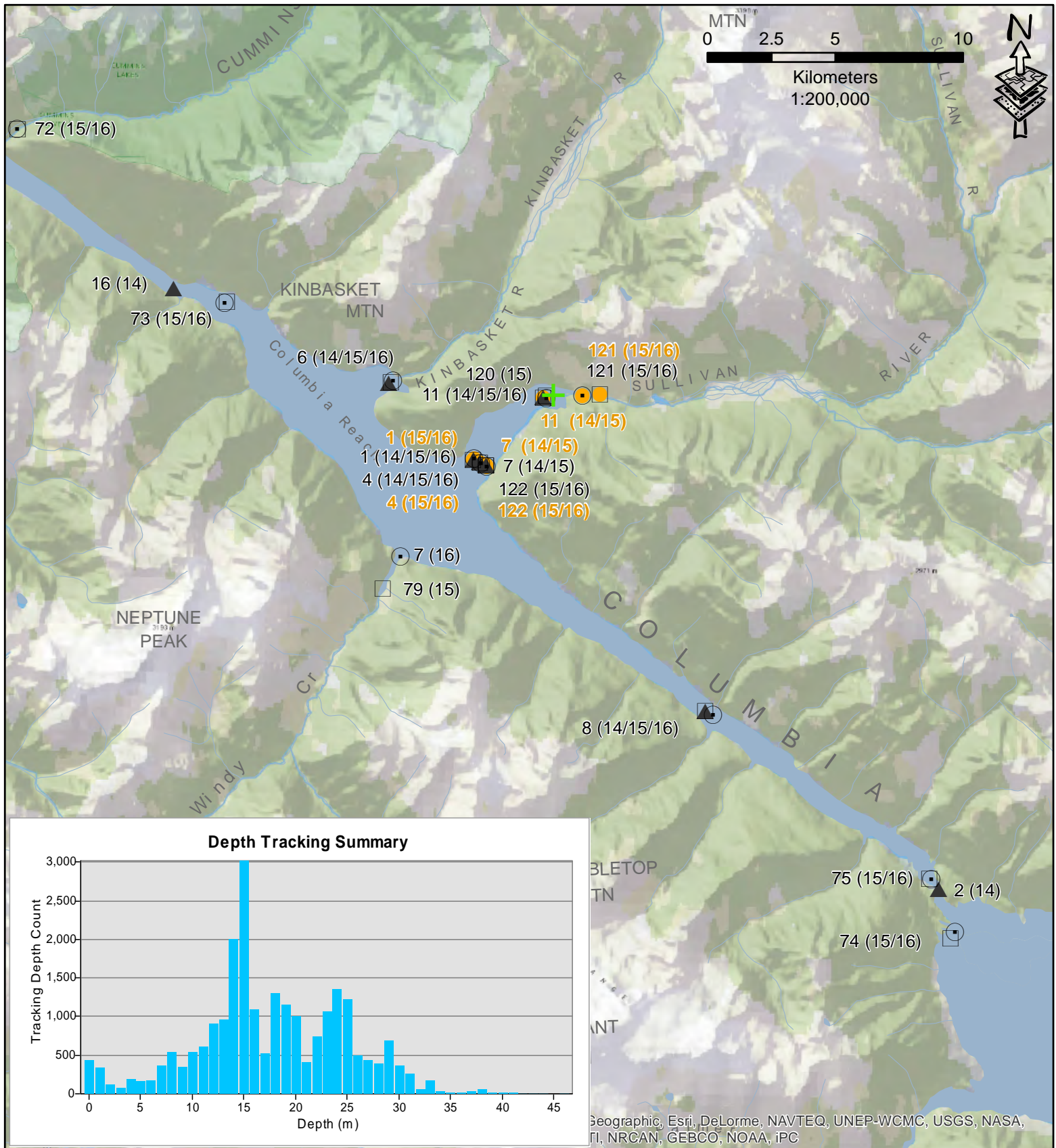


**Kinbasket Reservoir Burbot Tracking  
Acoustic Code: 30400**

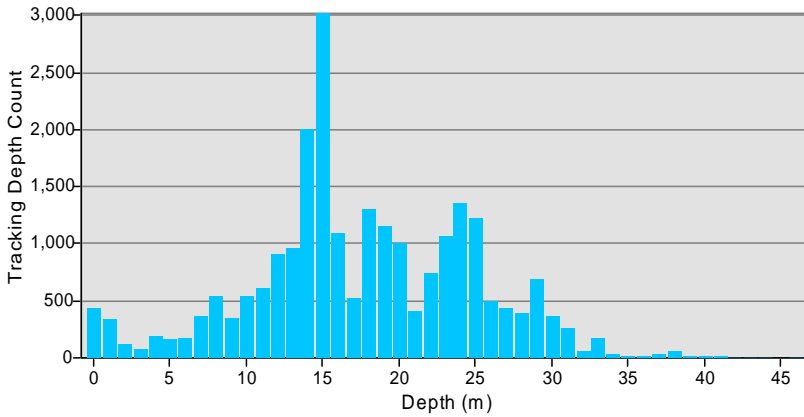
- Receiver - Tracking Location (Year)
- ▲ 2014
- ✚ Capture Location
- 2015
- 2016

<b>Receiver ID</b>	7	11
<b>Tracking Count</b>	4	174
<b>Tracking Date Range</b>	08/06/2014 to 08/06/2014	03/06/2014 to 19/11/2014
<b>Depth Range</b>	7m - 9m	4m - 41m
<b>Average Depth</b>	8.m	8.1m





**Depth Tracking Summary**



Geographic, Esri, DeLorme, NAVTEQ, UNEP-WCMC, USGS, NASA, FI, NRCAN, GEBCO, NOAA, IPC

● Receiver - Tracking Location (Year)

+ Capture Location

Receiver Location (Year)

▲ 2014

□ 2015

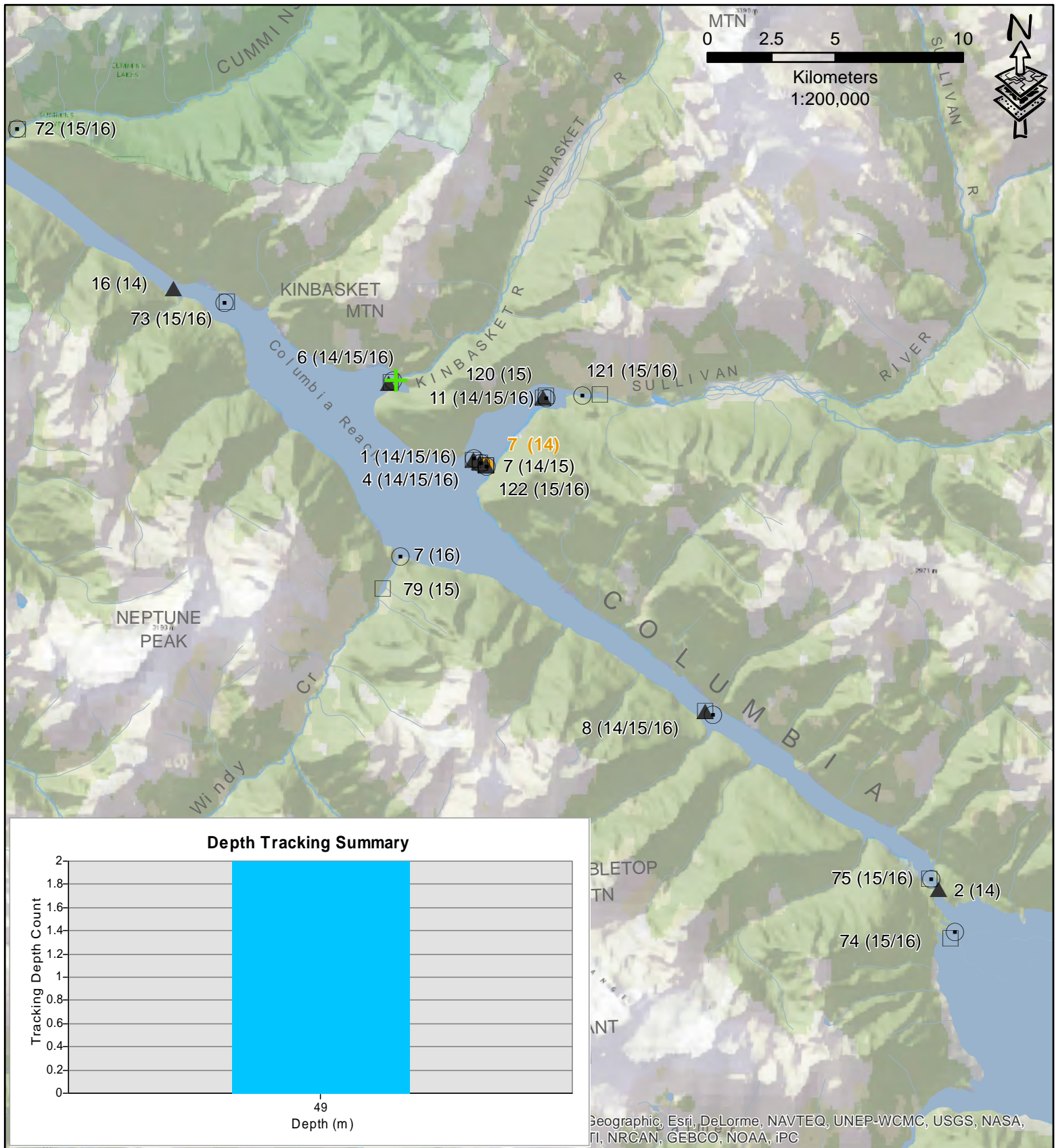
○ 2016

**Kinbasket Reservoir Burbot Tracking  
Acoustic Code: 30500**

Note: Missing location of receiver 113

Receiver ID	1	4	7	11	113	121	122
Tracking Count	607	1116	1483	17639	41	2425	474
Tracking Date Range	26/09/2015 to 09/03/2016	26/09/2015 to 23/04/2016	26/10/2014 to 23/03/2015	03/06/2014 to 12/02/2015	19/03/2016 to 20/04/2016	22/07/2015 to 14/01/2016	26/09/2015 to 21/04/2016
Depth Range	4m - 44m	4m - 39m	11m - 43m	6m - 41m	22m - 46m	0m - 13m	5m - 39m
Average Depth	16.8m	17.3m	24.4m	18.8m	29.2m	4.6m	16.8m



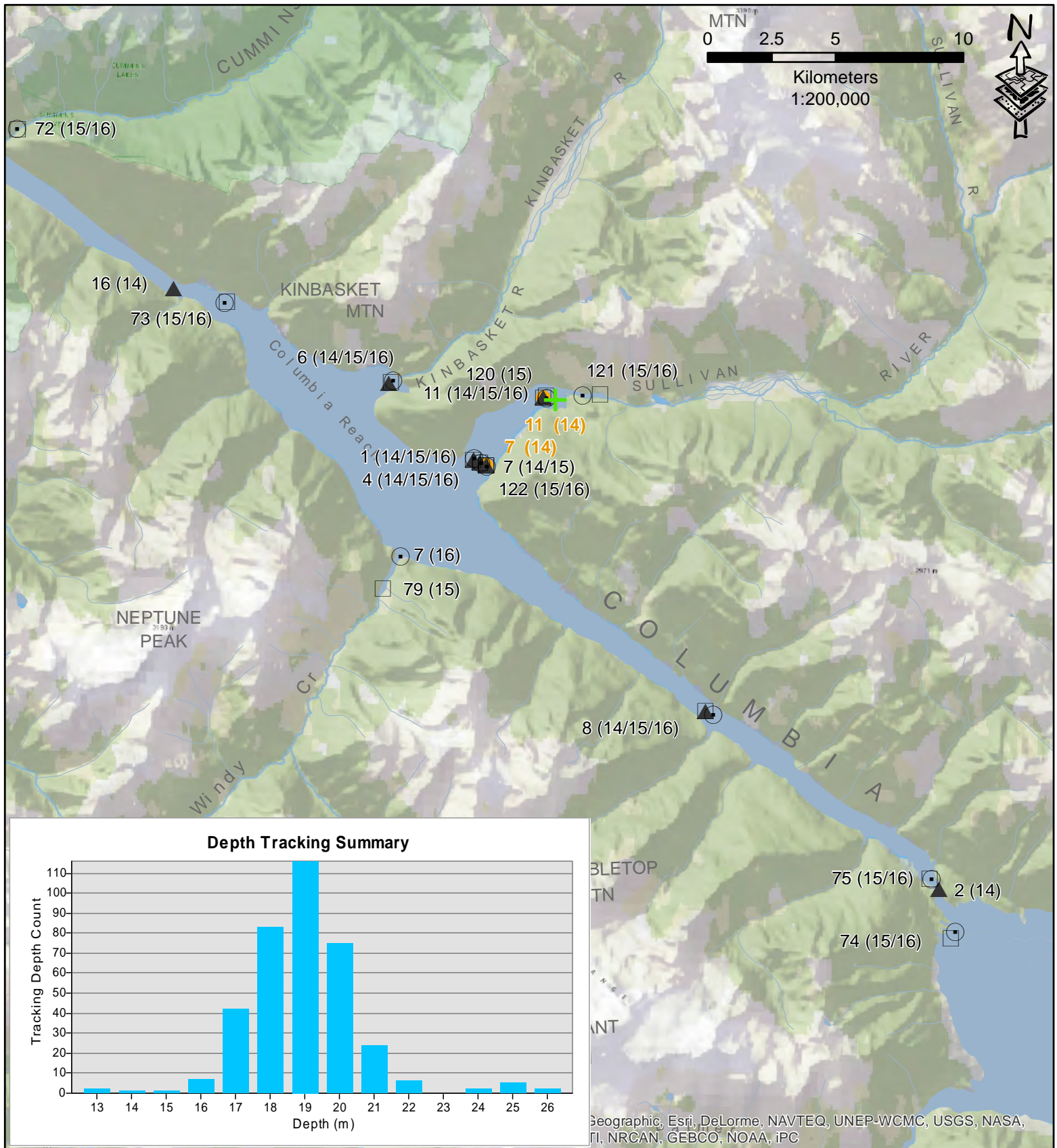


### Kinbasket Reservoir Burbot Tracking Acoustic Code: 30600

- Receiver - Tracking Location (Year)
- ▲ 2014
- ⊕ Capture Location
- 2015
- ⊙ 2016

Receiver ID	7
Tracking Count	2
Tracking Date Range	07/12/2014 to 09/12/2014
Depth Range	49m - 49m
Average Depth	49.m



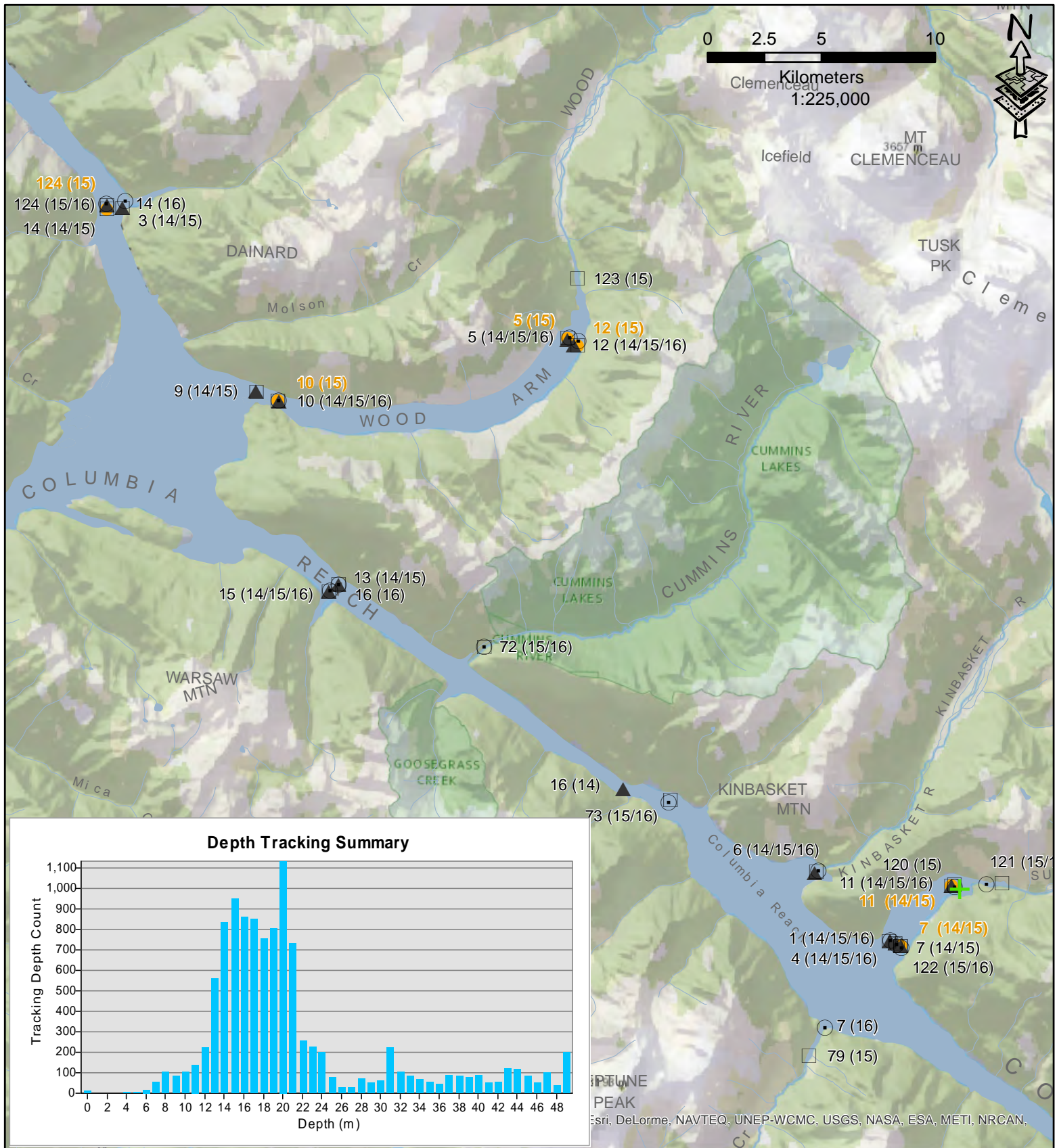


### Kinbasket Reservoir Burbot Tracking Acoustic Code: 30700

- Receiver - Tracking Location (Year)
- ⊕ Capture Location
- ▲ 2014
- 2015
- 2016

<b>Receiver ID</b>	7	11
<b>Tracking Count</b>	21	345
<b>Tracking Date Range</b>	19/06/2014 to 22/06/2014	19/06/2014 to 22/06/2014
<b>Depth Range</b>	16m - 20m	13m - 26m
<b>Average Depth</b>	17.9m	19.m



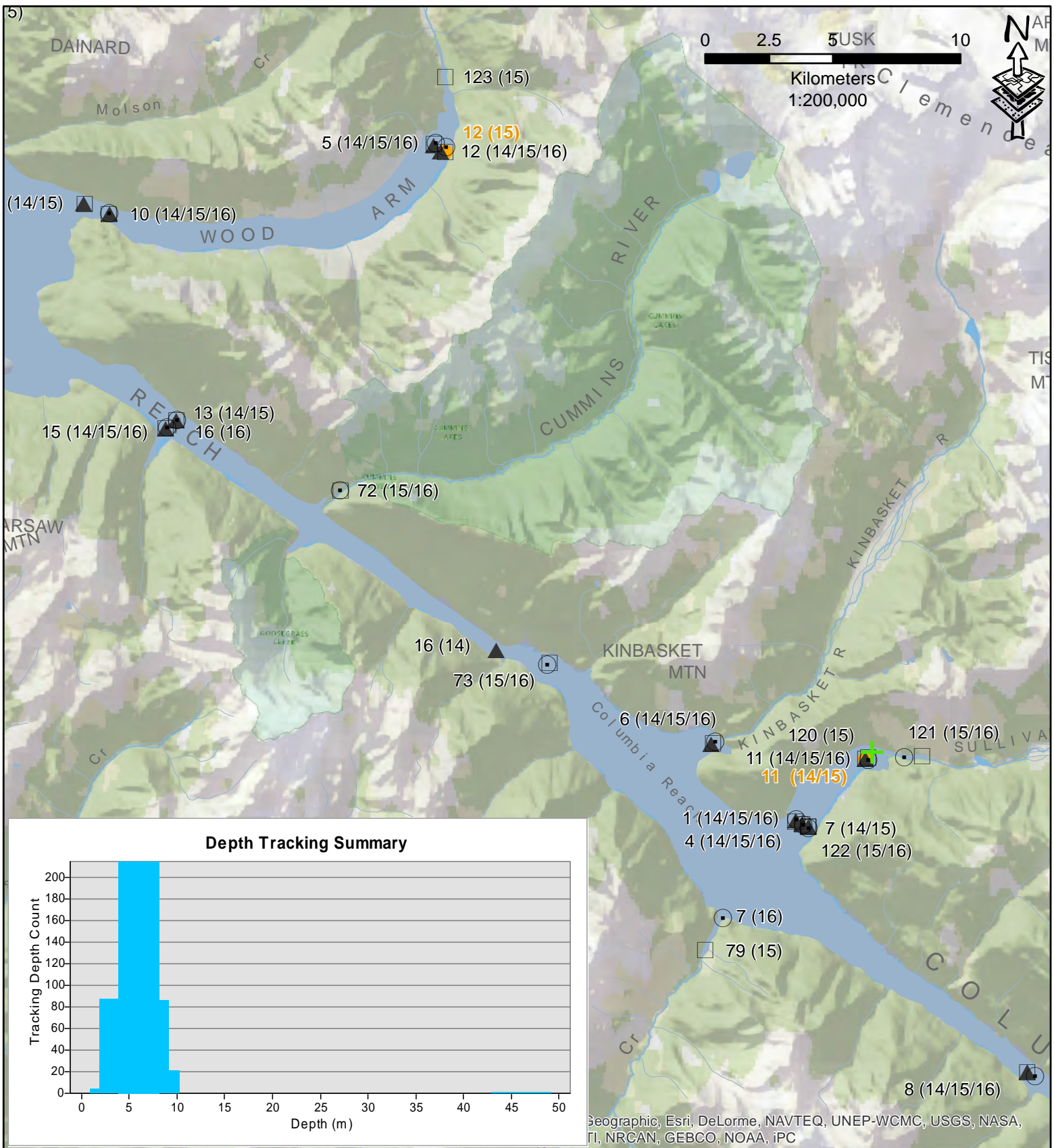


### Kinbasket Reservoir Burbot Tracking Acoustic Code: 30900

- Receiver - Tracking Location (Year)
- ✚ Capture Location
- Receiver Location (Year)
- ▲ 2014
- 2015
- 2016

Receiver ID	5	7	10	11	12	124
<b>Tracking Count</b>	29	1058	4	9646	74	177
<b>Tracking Date Range</b>	18/05/2015 to 05/06/2015	06/10/2014 to 18/02/2015	06/06/2015 to 06/06/2015	03/06/2014 to 06/02/2015	15/05/2015 to 05/06/2015	04/10/2015 to 14/11/2015
<b>Depth Range</b>	6m - 14m	11m - 49m	10m - 11m	6m - 49m	4m - 13m	0m - 49m
<b>Average Depth</b>	8.7m	42.2m	10.8m	18.5m	8.1m	33.6m



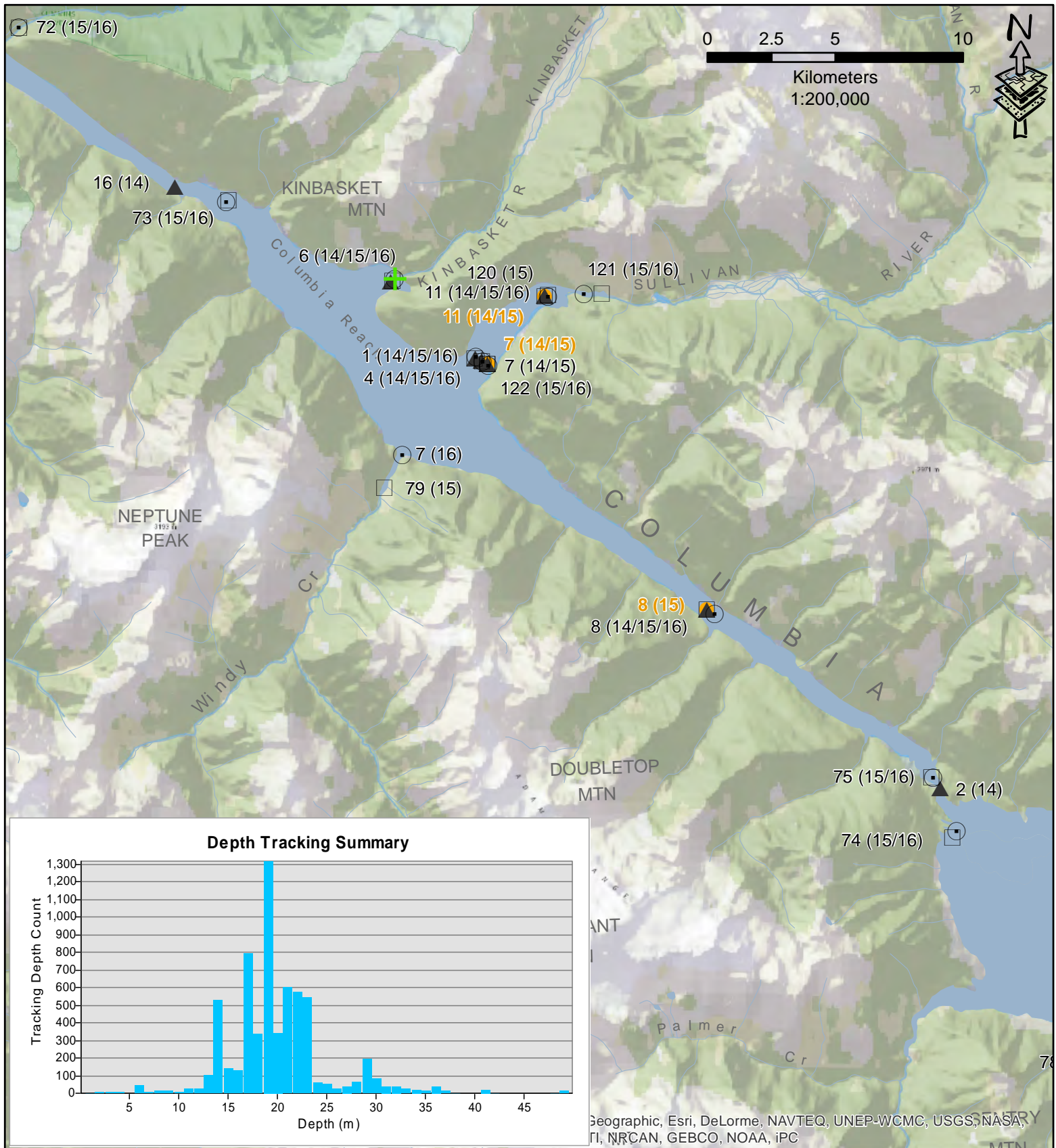


### Kinbasket Reservoir Burbot Tracking Acoustic Code: 31000

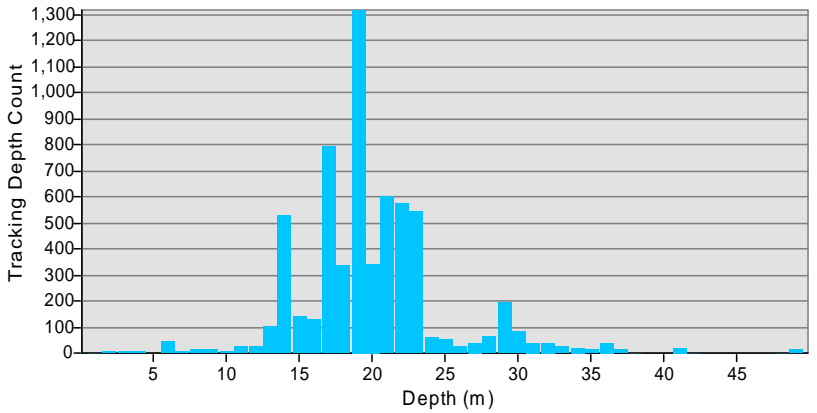
- Receiver - Tracking Location (Year)
- ▲ 2014
- ⊕ Capture Location
- 2015
- ⊙ 2016

Receiver ID	11	12
Tracking Count	486	1
Tracking Date Range	03/06/2014 to 06/01/2015	25/10/2015 to 25/10/2015
Depth Range	3m - 47m	45m - 45m
Average Depth	5.8m	45.m





**Depth Tracking Summary**

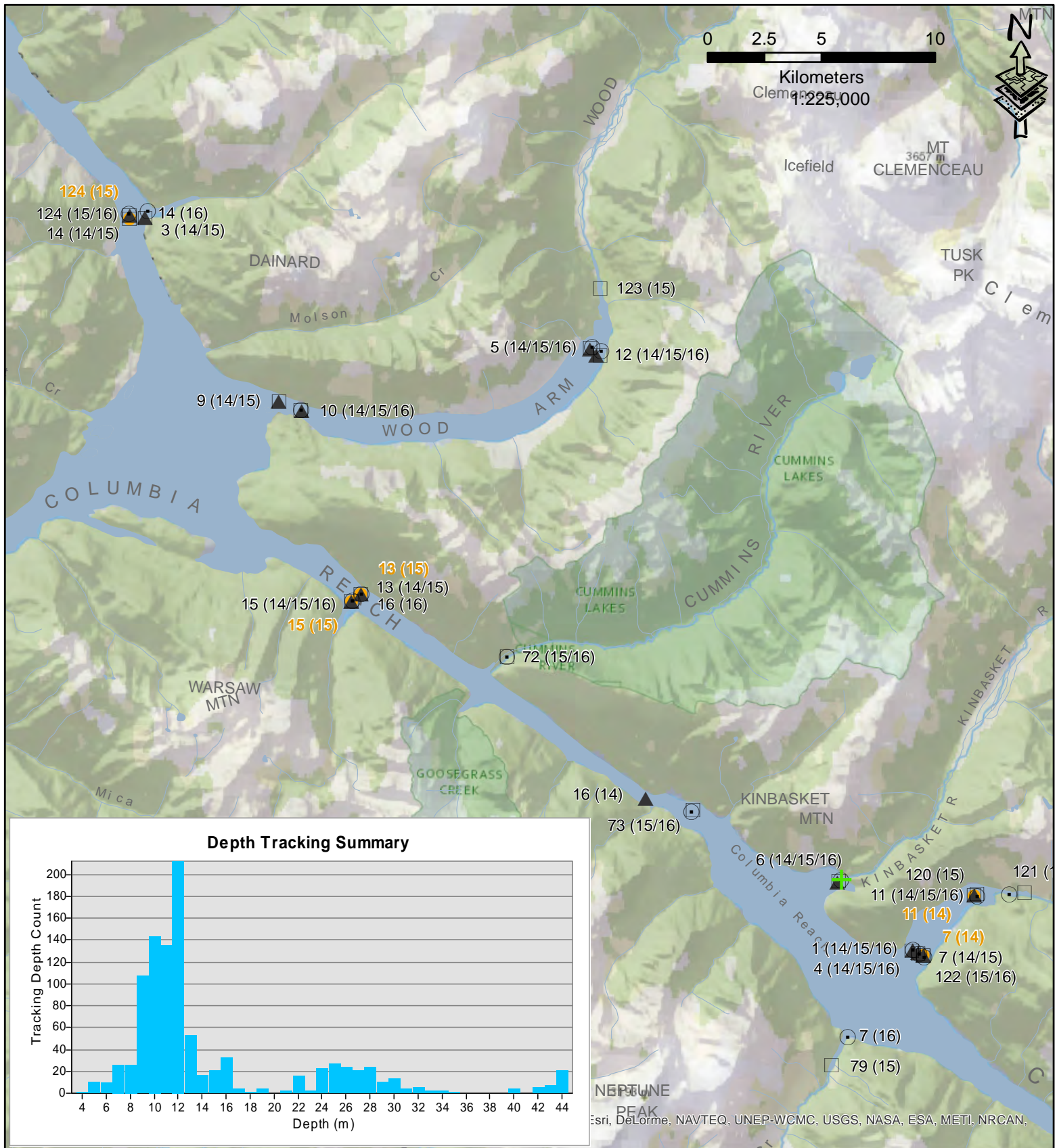


**Kinbasket Reservoir Burbot Tracking  
Acoustic Code: 31100**

- Receiver - Tracking Location (Year)
- ▲ 2014
- ⊕ Capture Location
- 2015
- ⊙ 2016

Receiver ID	7	8	11
Tracking Count	380	18	5906
Tracking Date Range	16/10/2014 to 02/04/2015	07/07/2015 to 06/11/2015	17/10/2014 to 18/01/2015
Depth Range	1m - 41m	38m - 49m	1m - 36m
Average Depth	24.5m	47.5m	19.6m



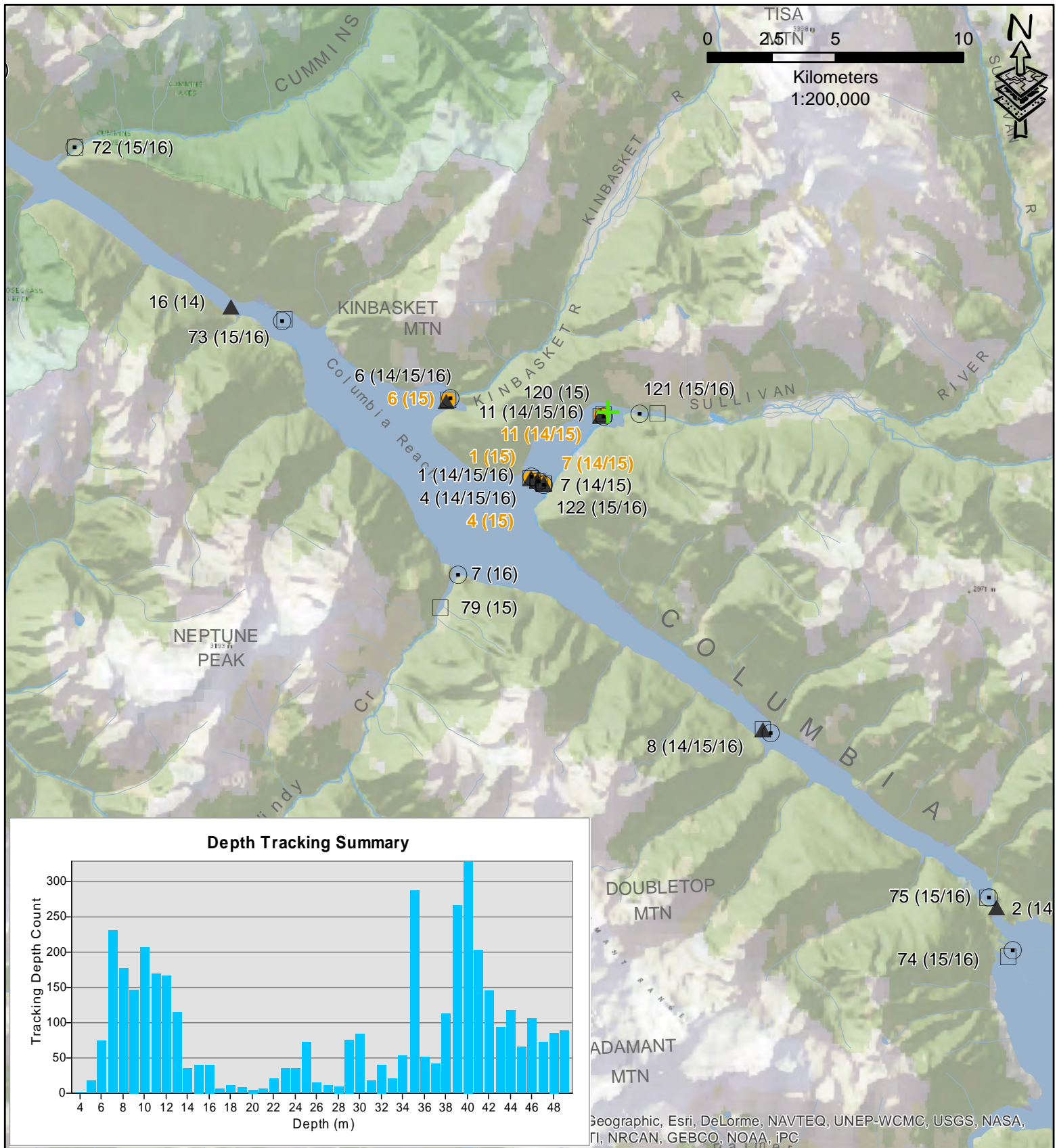


- Receiver - Tracking Location (Year)
- ✚ Capture Location
- Receiver Location (Year)
- ▲ 2014
- 2015
- 2016

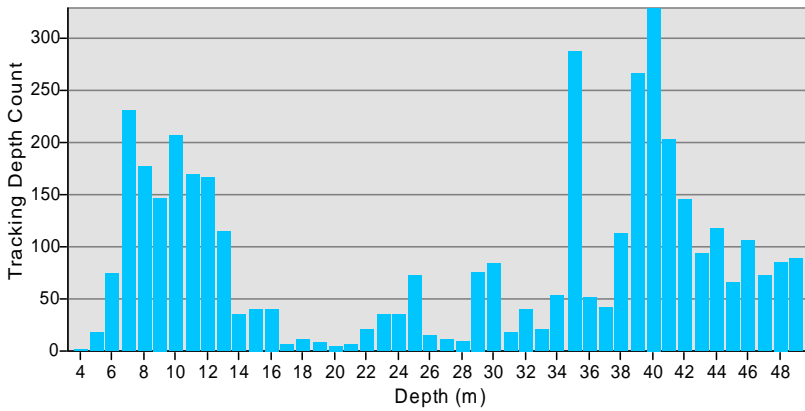
### Kinbasket Reservoir Burbot Tracking Acoustic Code: 31200

Receiver ID	7	11	124	13	15
<b>Tracking Count</b>	186	721	79	12	16
<b>Tracking Date Range</b>	17/06/2014 to 04/11/2014	18/06/2014 to 03/11/2014	24/07/2015 to 11/08/2015	18/06/2015 to 18/06/2015	18/06/2015 to 18/06/2015
<b>Depth Range</b>	7m - 44m	4m - 44m	21m - 35m	12m - 16m	13m - 17m
<b>Average Depth</b>	20.5m	12.4m	24.7m	14.2m	14.6m





**Depth Tracking Summary**



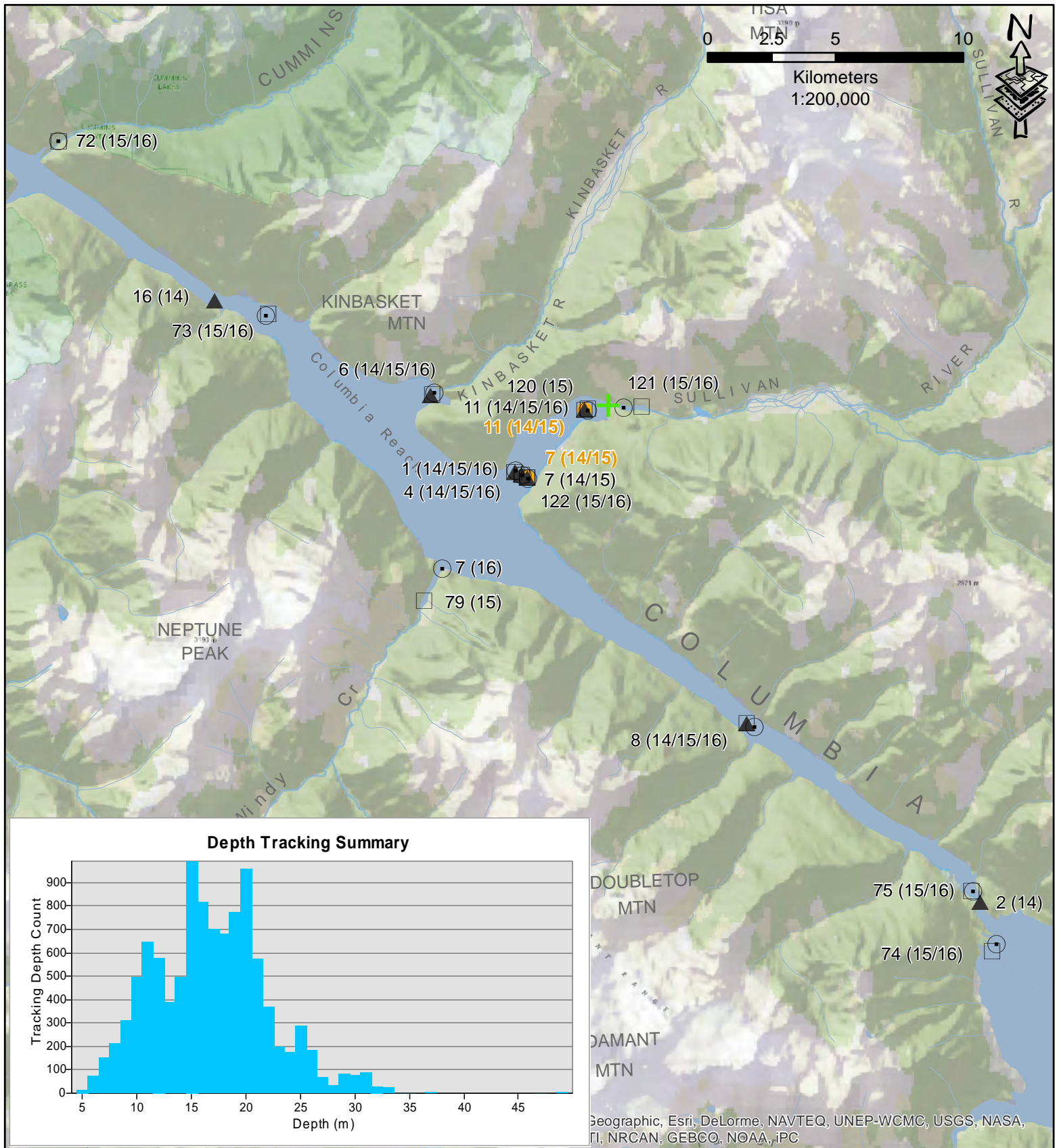
Geographic, Esri, DeLorme, NAVTEQ, UNEP-WCMC, USGS, NASA, FI, NRCAN, GEBCO, NOAA, IPC

- Receiver - Tracking Location (Year)
- Capture Location
- Receiver Location (Year)
- ▲ 2014
- 2015
- 2016

**Kinbasket Reservoir Burbot Tracking**  
Acoustic Code: 31300

Receiver ID	1	4	6	7	11
Tracking Count	9	2	40	2458	1508
Tracking Date Range	23/06/2015 to 29/06/2015	23/06/2015 to 24/06/2015	24/06/2015 to 28/06/2015	06/07/2014 to 30/03/2015	03/06/2014 to 11/02/2015
Depth Range	49m - 49m	49m - 49m	49m - 49m	13m - 49m	4m - 47m
Average Depth	49.m	49.m	49.m	38.m	11.6m



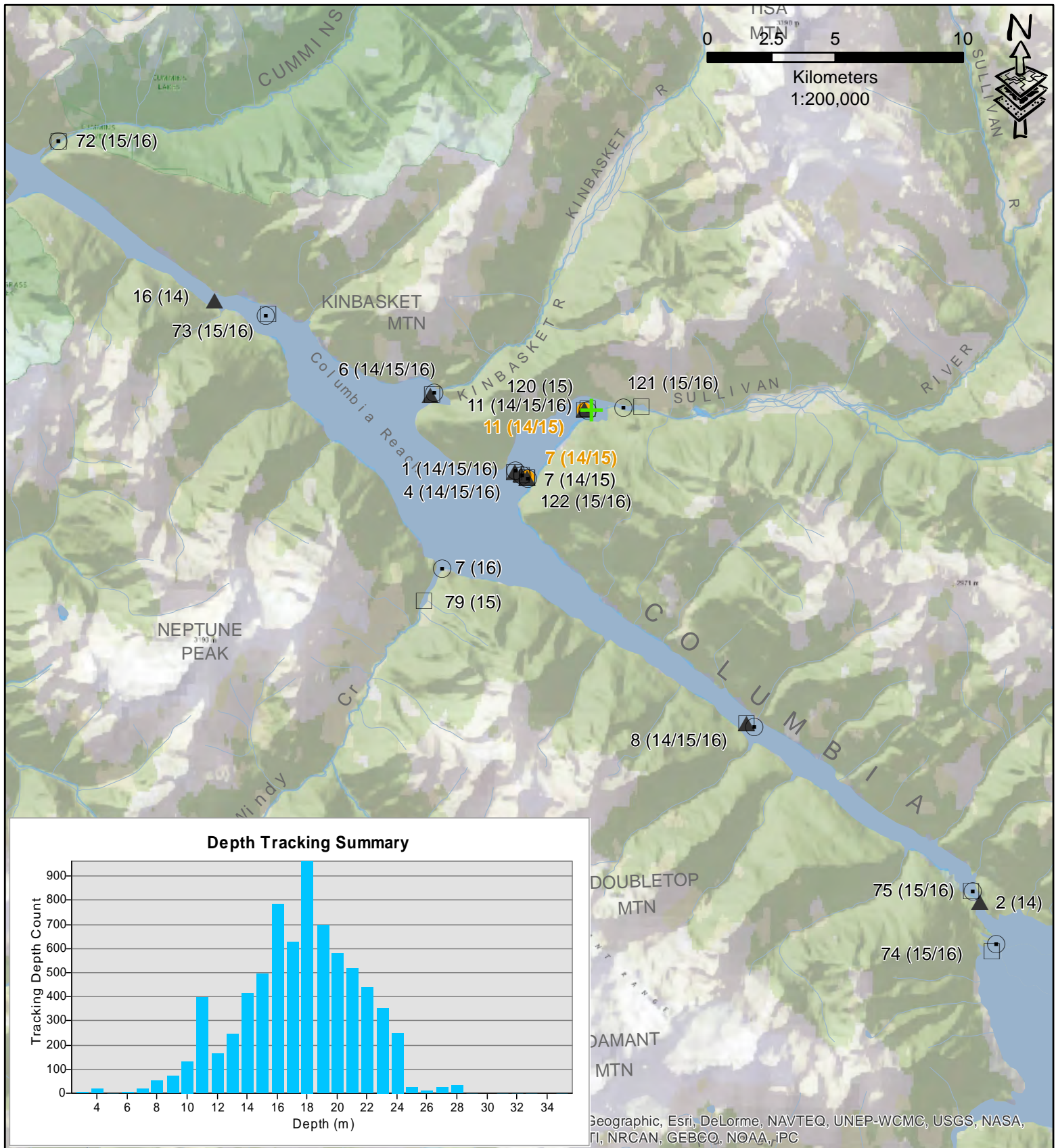


### Kinbasket Reservoir Burbot Tracking Acoustic Code: 31400

- Receiver - Tracking Location (Year)
- + Capture Location
- ▲ 2014
- 2015
- 2016

Receiver ID	7	11
Tracking Count	895	9604
Tracking Date Range	16/10/2014 to 02/04/2015	03/06/2014 to 01/02/2015
Depth Range	8m - 49m	5m - 35m
Average Depth	20.m	16.5m



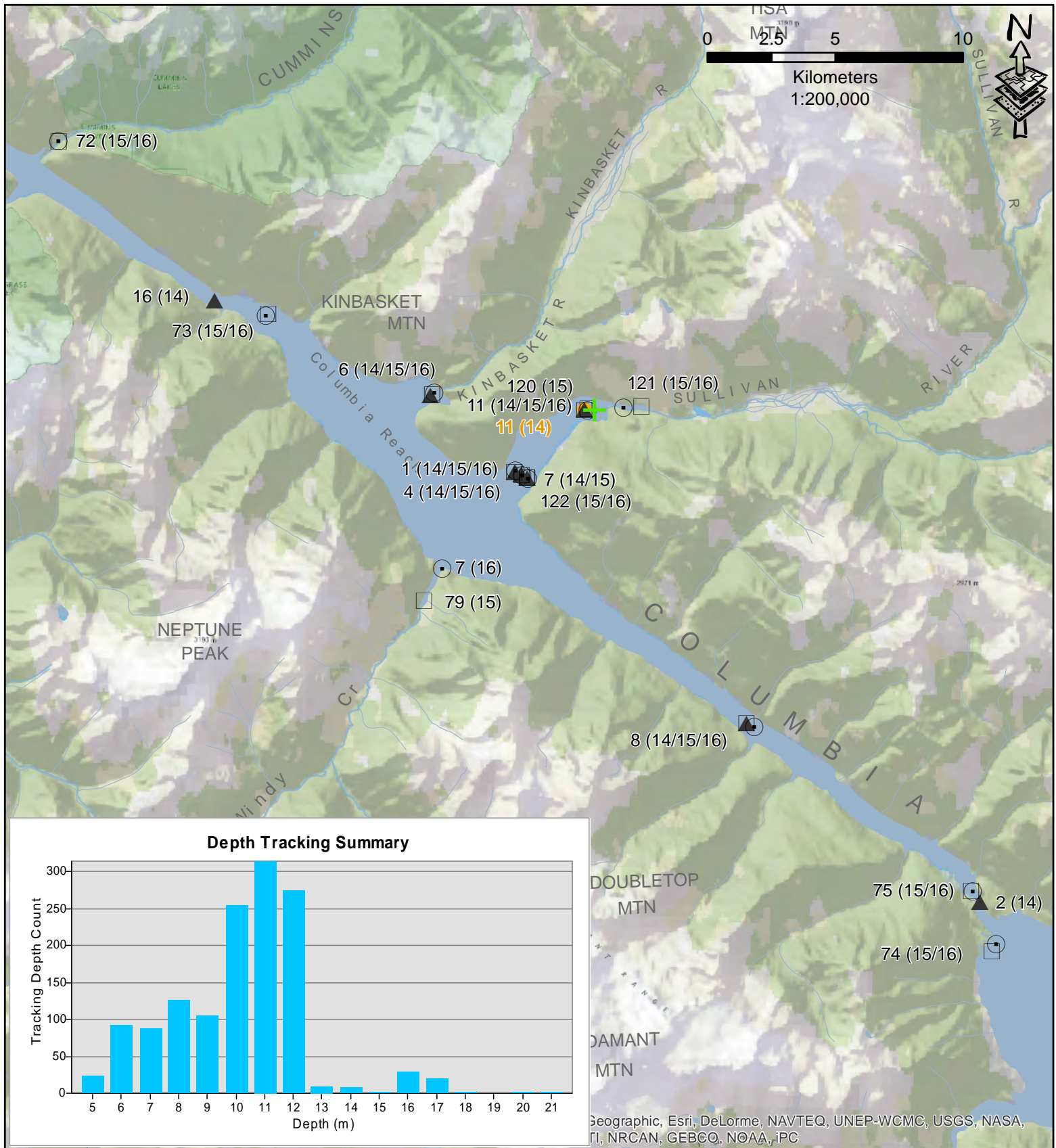


### Kinbasket Reservoir Burbot Tracking Acoustic Code: 31500

- Receiver - Tracking Location (Year)
- ▲ 2014
- ⊕ Capture Location
- 2015
- ⊙ 2016

Receiver ID	7	11
Tracking Count	133	7201
Tracking Date Range	10/11/2014 to 21/01/2015	04/06/2014 to 21/01/2015
Depth Range	7m - 33m	3m - 35m
Average Depth	20.4m	17.4m



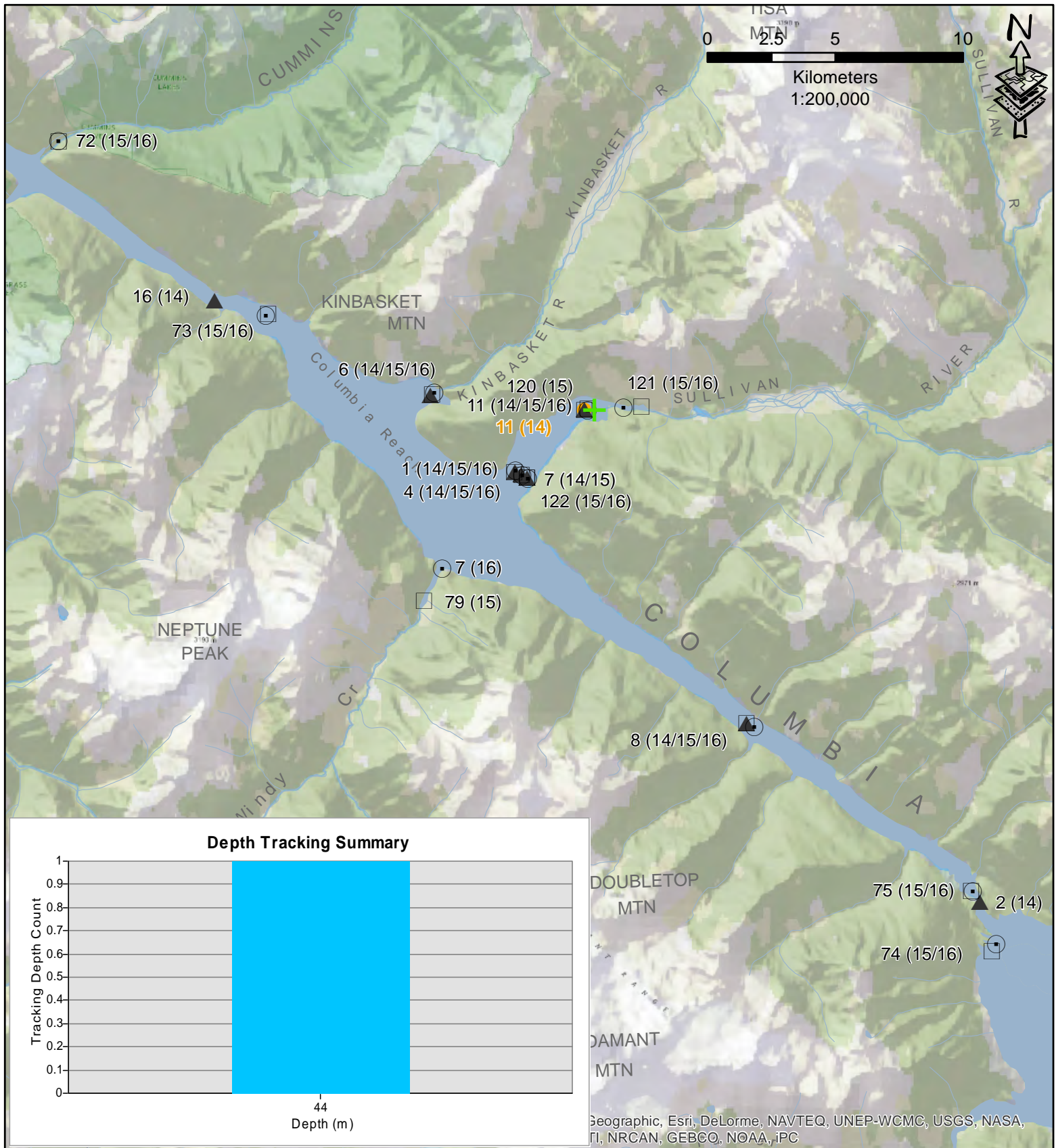


### Kinbasket Reservoir Burbot Tracking Acoustic Code: 31600

- Receiver - Tracking Location (Year)
- ▲ 2014
- ⊕ Capture Location
- 2015
- ⊙ 2016

<b>Receiver ID</b>	11
<b>Tracking Count</b>	1346
<b>Tracking Date Range</b>	06/06/2014 to 01/07/2014
<b>Depth Range</b>	5m - 21m
<b>Average Depth</b>	10.1m



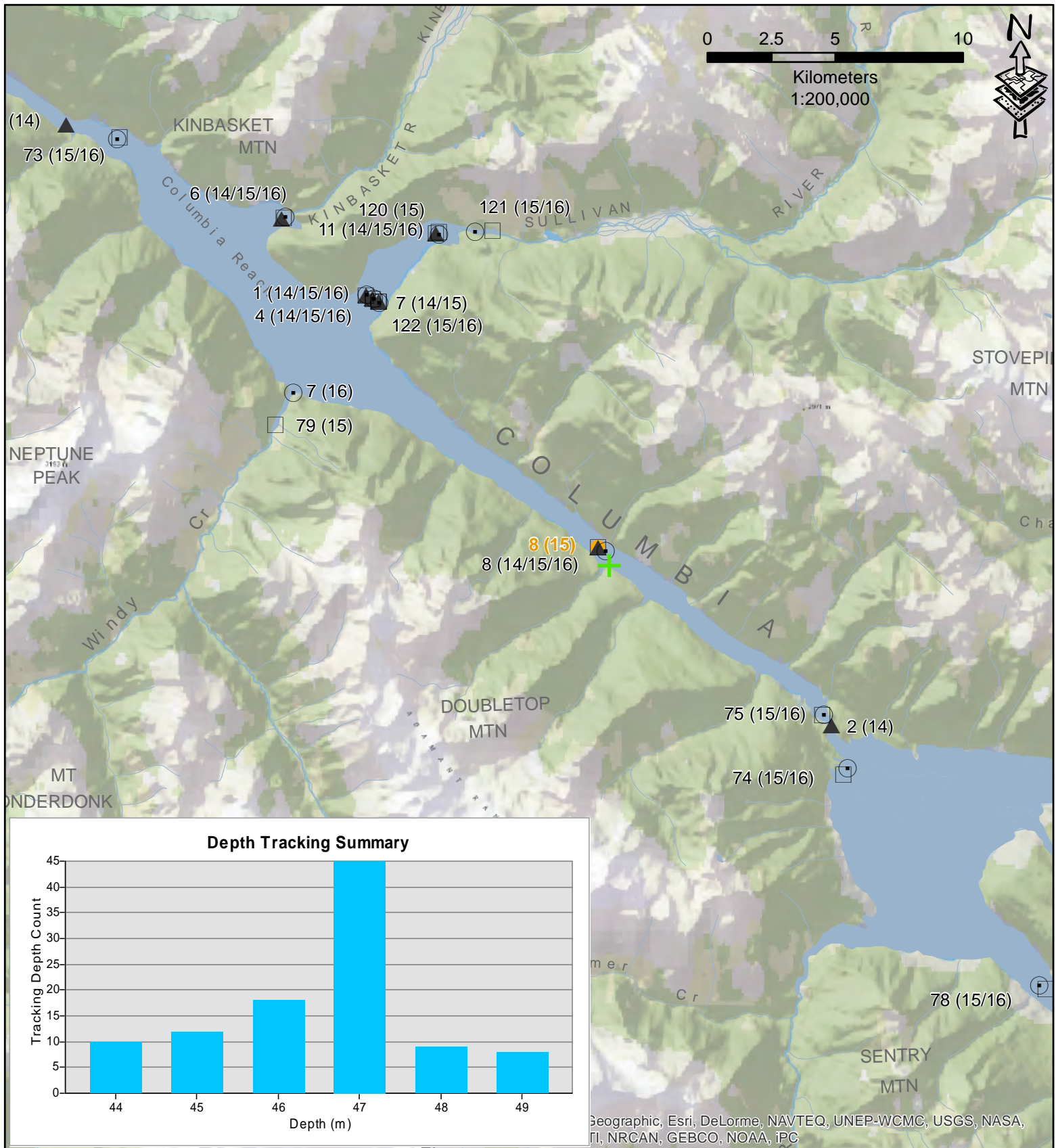


### Kinbasket Reservoir Burbot Tracking Acoustic Code: 31700

- Receiver - Tracking Location (Year)
- + Capture Location
- ▲ 2014
- 2015
- 2016

<b>Receiver ID</b>	11
<b>Tracking Count</b>	1
<b>Tracking Date Range</b>	22/12/2014 to 22/12/2014
<b>Depth Range</b>	44m - 44m
<b>Average Depth</b>	44.m





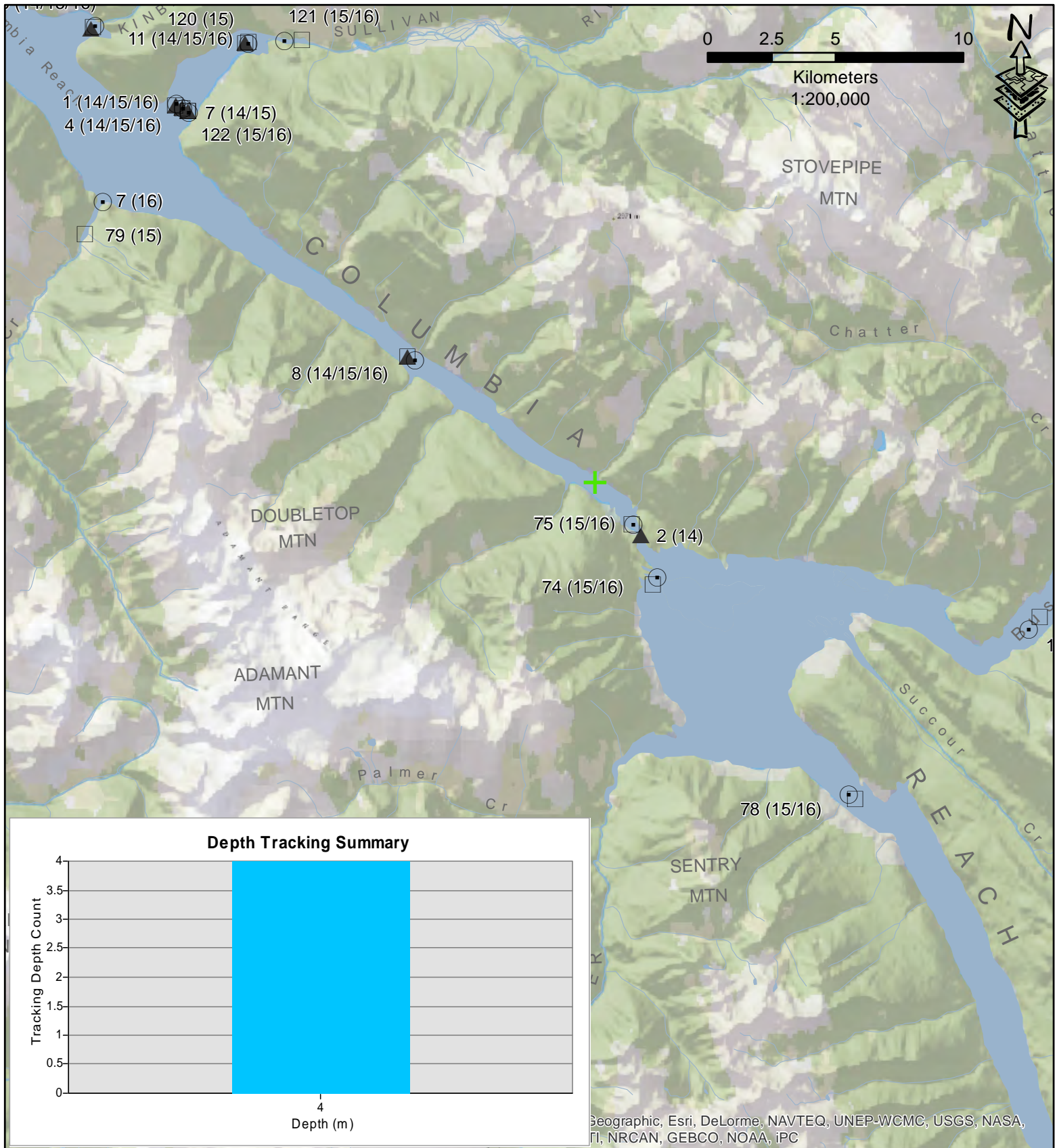
Geographic, Esri, DeLorme, NAVTEQ, UNEP-WCMC, USGS, NASA, FI, NRCAN, GEBCO, NOAA, IPC

### Kinbasket Reservoir Burbot Tracking Acoustic Code: 31800

- Receiver - Tracking Location (Year)
- ▲ 2014
- + Capture Location
- 2015
- 2016

<b>Receiver ID</b>	8
<b>Tracking Count</b>	102
<b>Tracking Date Range</b>	13/06/2015 to 14/12/2015
<b>Depth Range</b>	44m - 49m
<b>Average Depth</b>	46.5m





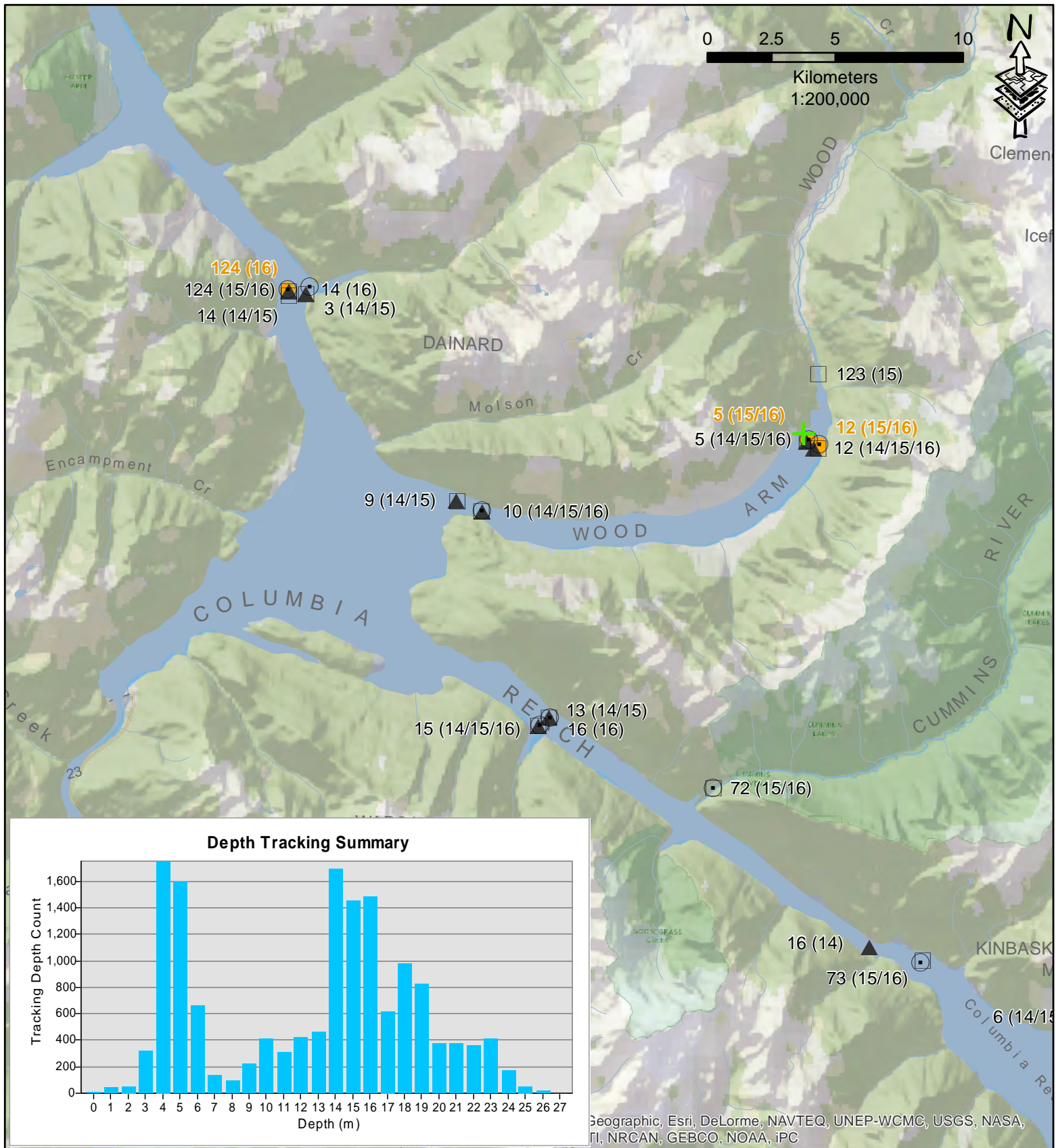
### Kinbasket Reservoir Burbot Tracking Acoustic Code: 32400

- + Capture Location
- Receiver Location (Year)
  - ▲ 2014
  - 2015
  - 2016

<b>Receiver ID</b>	114
<b>Tracking Count</b>	4
<b>Tracking Date Range</b>	28/07/2015 to 29/07/2015
<b>Depth Range</b>	4m - 4m
<b>Average Depth</b>	4.m

Note: Missing location of receiver 114

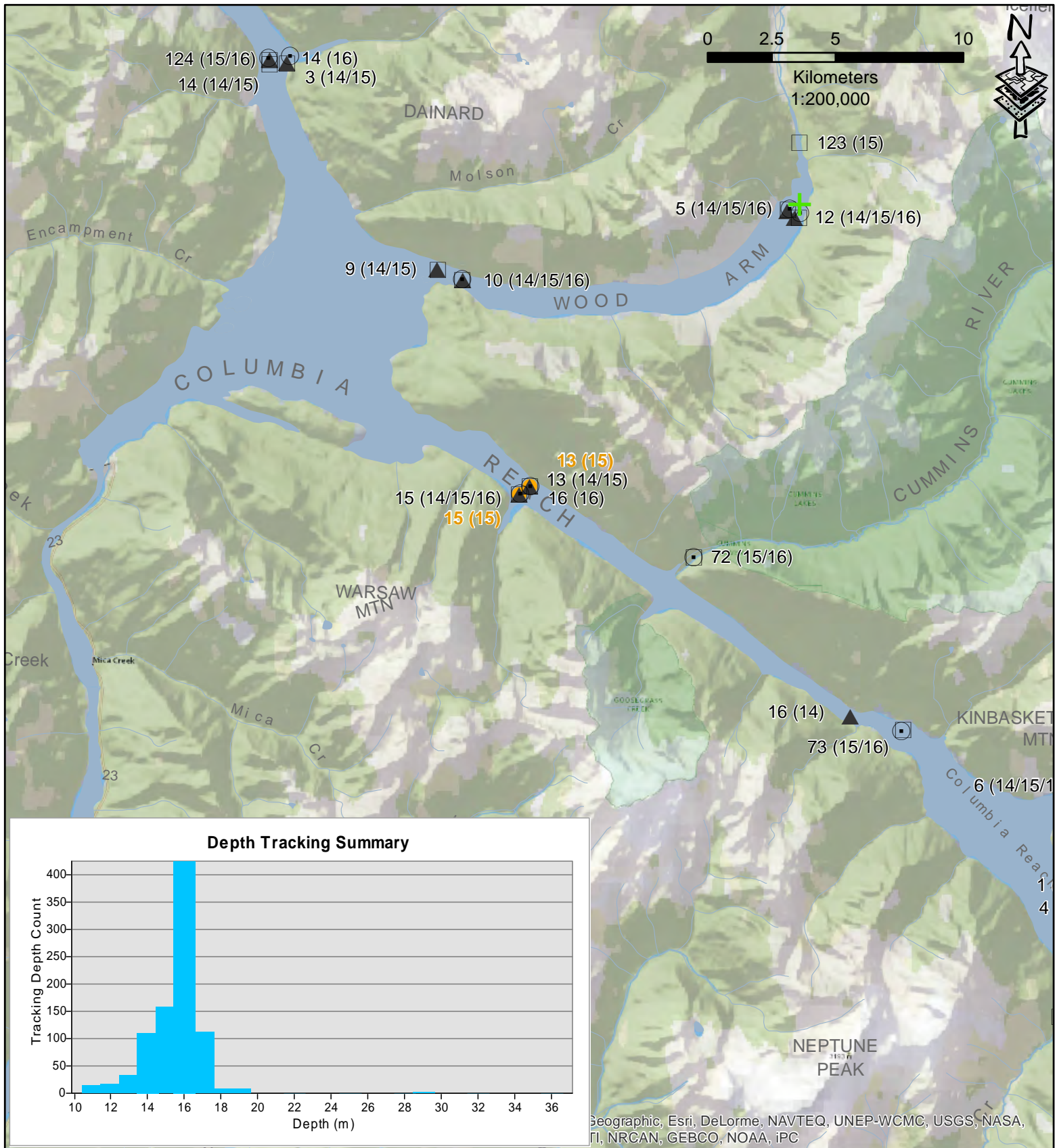




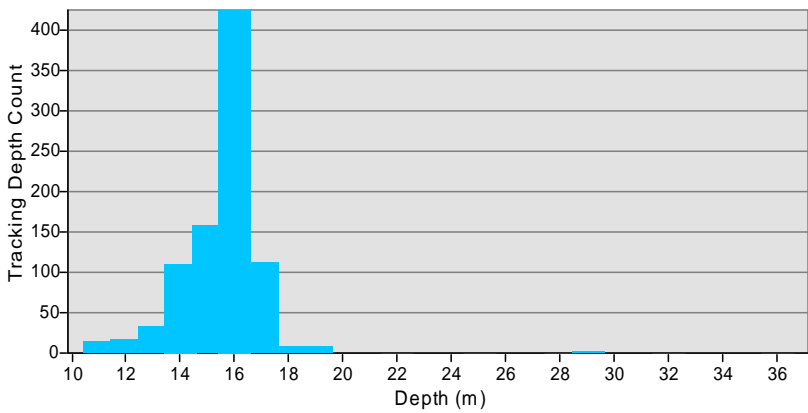
### Kinbasket Reservoir Burbot Tracking Acoustic Code: 32500

- Receiver - Tracking Location (Year)
- ▲ 2014
- ⊕ Capture Location
- 2015
- ⊙ 2016

Receiver ID	5	12	124
Tracking Count	6283	9043	2
Tracking Date Range	23/05/2015 to 22/04/2016	23/05/2015 to 20/03/2016	16/04/2016 to 16/04/2016
Depth Range	0m - 26m	2m - 27m	21m - 27m
Average Depth	13.3m	12.3m	24.m



**Depth Tracking Summary**



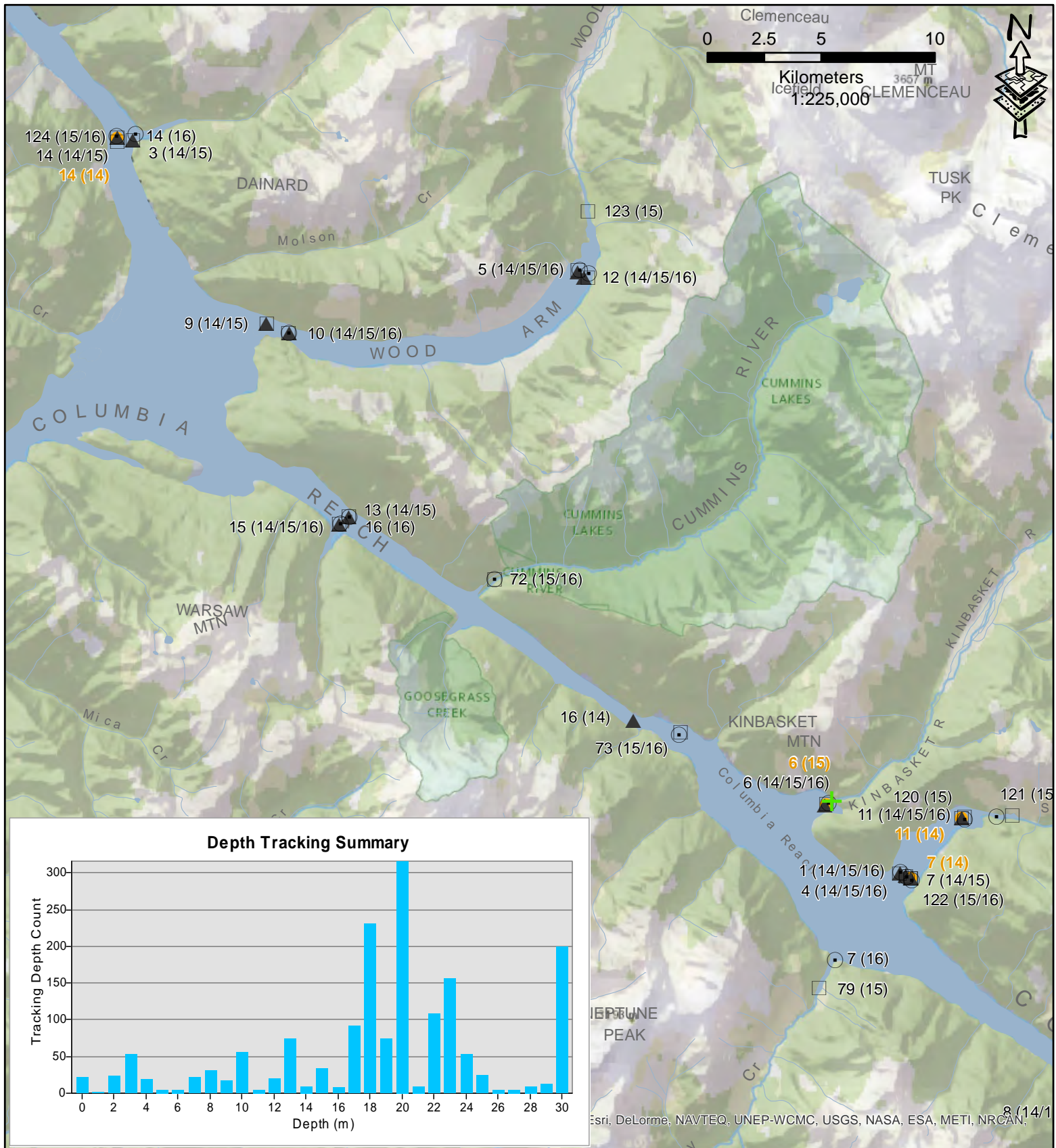
Geographic, Esri, DeLorme, NAVTEQ, UNEP-WCMC, USGS, NASA, FI, NRCAN, GEBCO, NOAA, IPC

**Kinbasket Reservoir Burbot Tracking  
Acoustic Code: 32600**

- Receiver - Tracking Location (Year)
- ▲ 2014
- ⊕ Capture Location
- 2015
- ⊙ 2016

Receiver ID	13	15
Tracking Count	694	200
Tracking Date Range	11/05/2015 to 01/06/2015	14/05/2015 to 01/06/2015
Depth Range	11m - 36m	11m - 29m
Average Depth	15.9m	14.4m



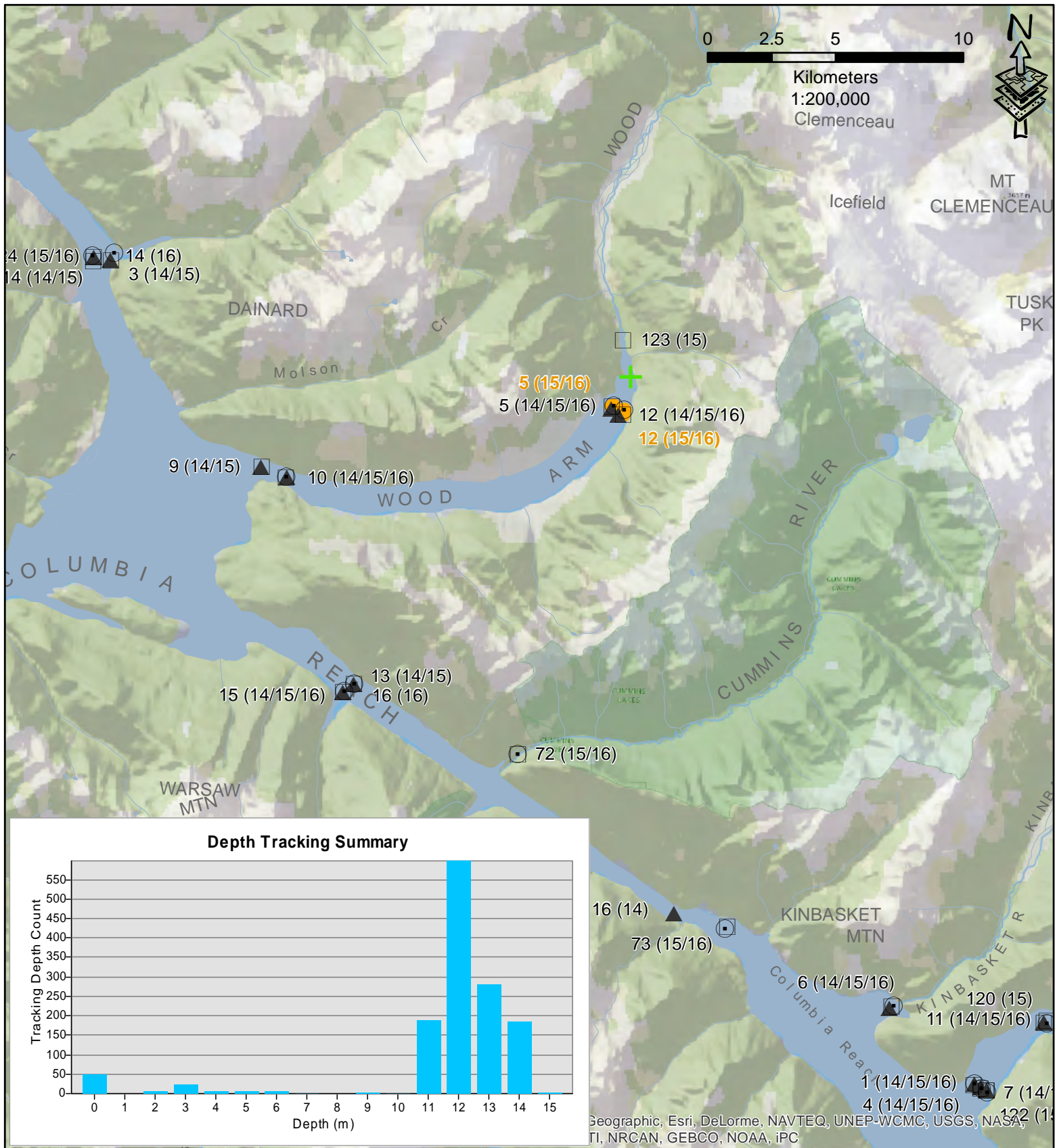


### Kinbasket Reservoir Burbot Tracking Acoustic Code: 32800

- Receiver - Tracking Receiver Location (Year)
- ▲ 2014
- 2015
- ⊙ 2016
- + Capture Location

Receiver ID	6	7	11	14
<b>Tracking Count</b>	1667	7	9	18
<b>Tracking Date Range</b>	12/05/2015 to 19/07/2015	29/05/2014 to 04/06/2014	29/05/2014 to 03/06/2014	29/05/2014 to 02/06/2014
<b>Depth Range</b>	1m - 30m	0m - 13m	0m - 13m	0m - 11m
<b>Average Depth</b>	19.1m	7.3m	5.8m	1.2m



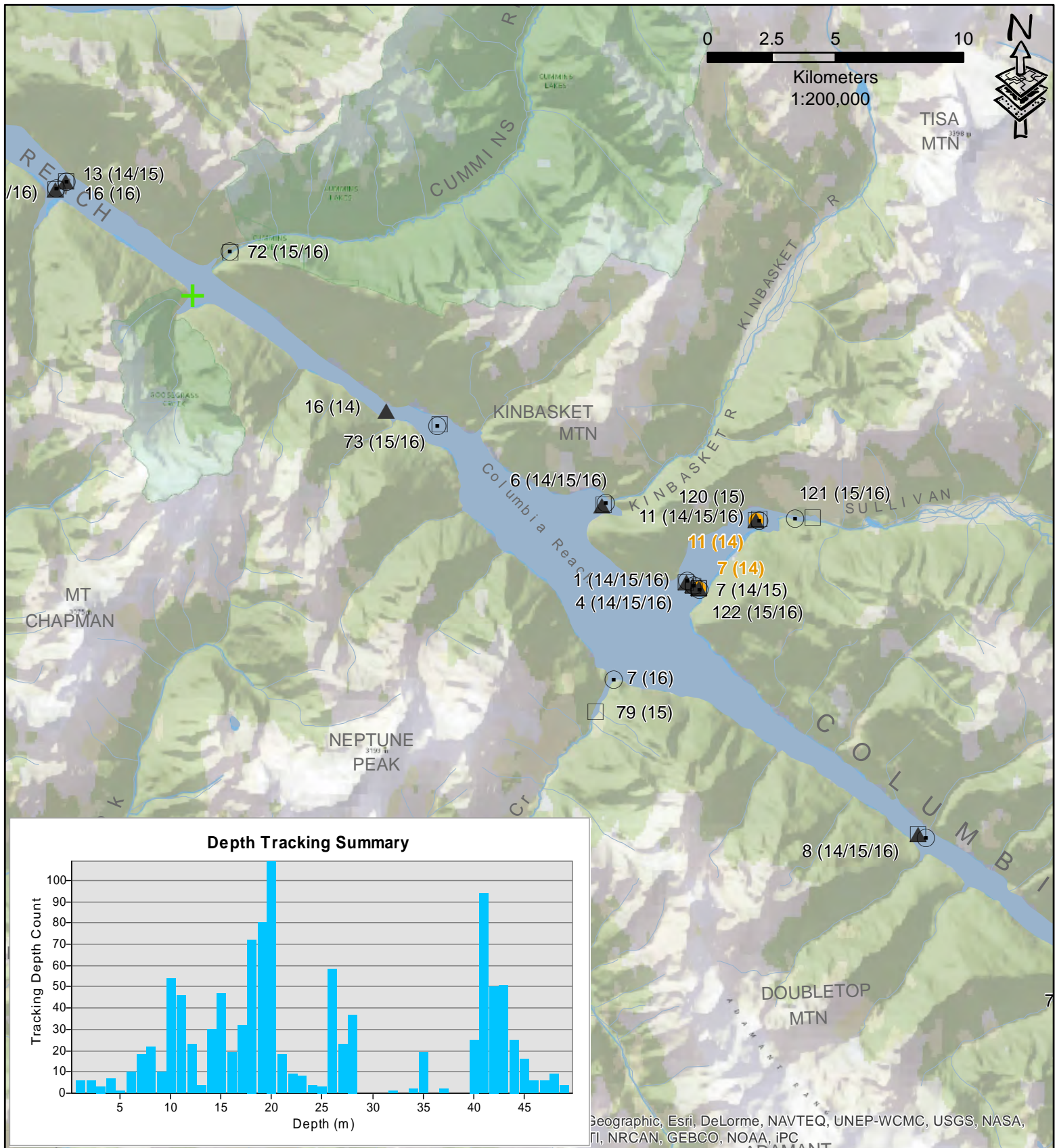


### Kinbasket Reservoir Burbot Tracking Acoustic Code: 32900

- Receiver - Tracking Location (Year)
- ▲ 2014
- ✚ Capture Location
- 2015
- ⊙ 2016

Receiver ID	5	12
Tracking Count	462	894
Tracking Date Range	31/05/2015 to 16/04/2016	15/05/2015 to 20/01/2016
Depth Range	0m - 14m	2m - 15m
Average Depth	10.5m	12.2m



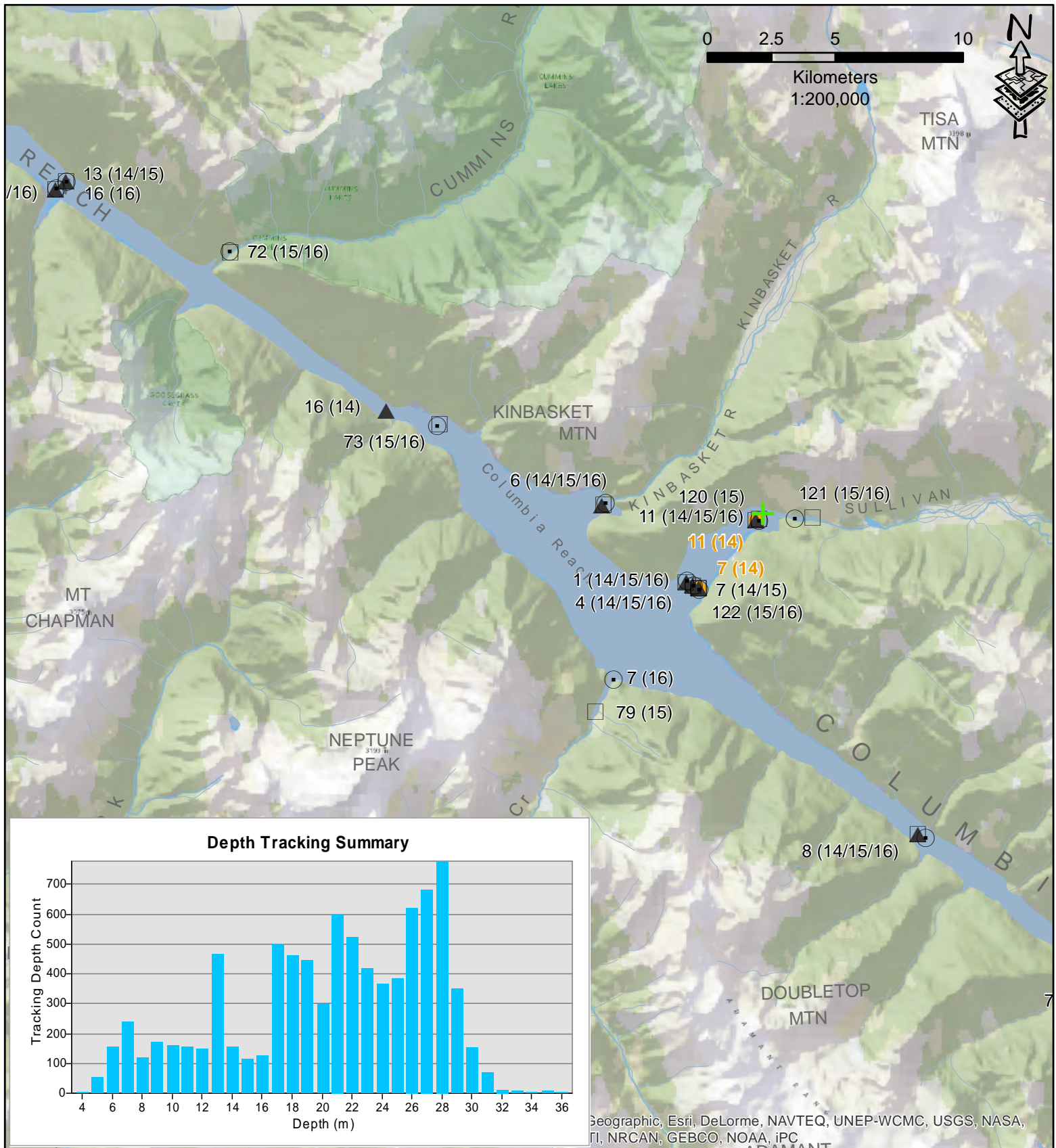


### Kinbasket Reservoir Burbot Tracking Acoustic Code: 33000

- Receiver - Tracking Location (Year)
- ▲ 2014
- ✚ Capture Location
- 2015
- 2016

Receiver ID	7	11
Tracking Count	353	716
Tracking Date Range	27/06/2014 to 24/12/2014	27/06/2014 to 22/12/2014
Depth Range	1m - 49m	1m - 42m
Average Depth	37.3m	17.8m



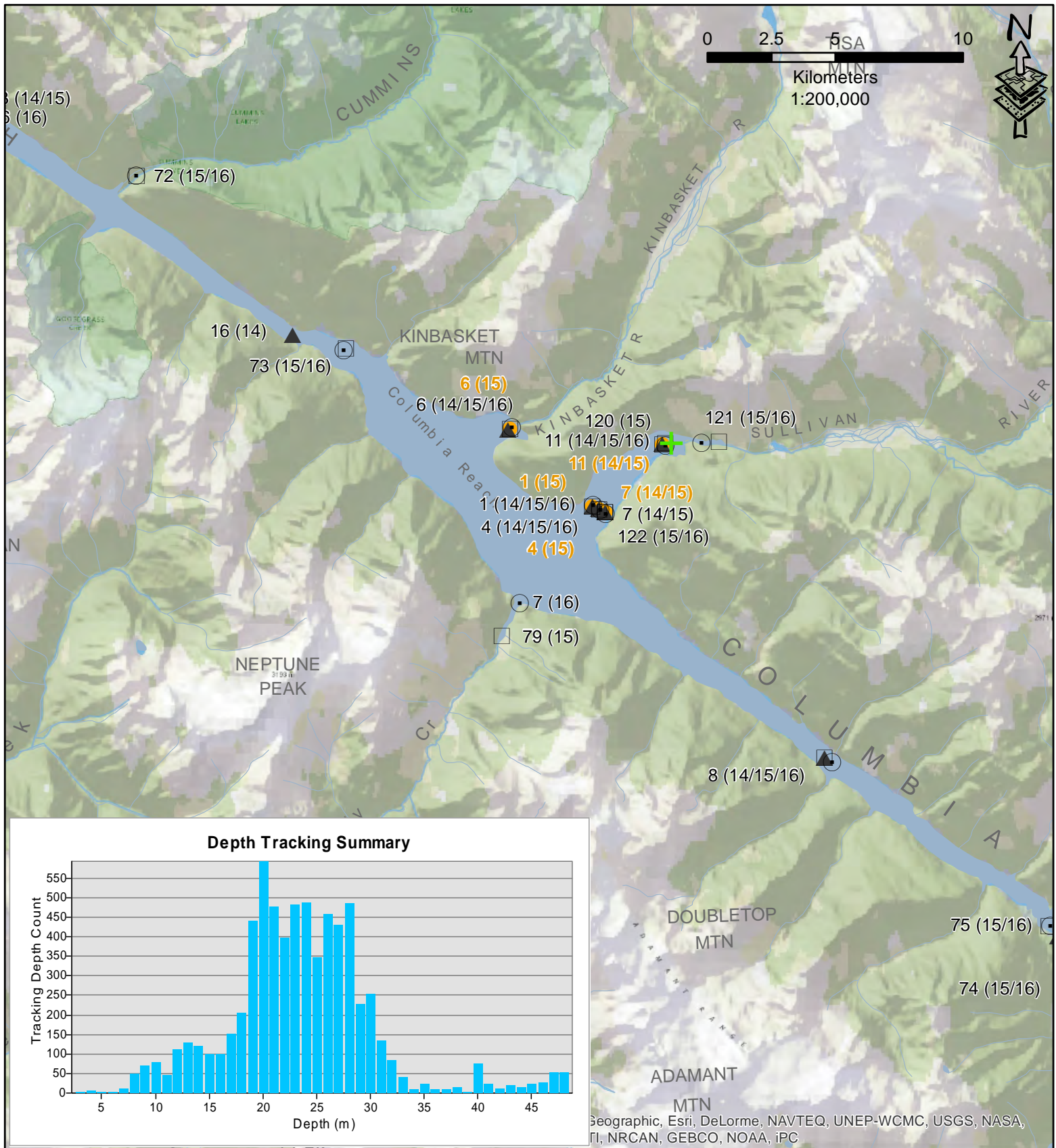


### Kinbasket Reservoir Burbot Tracking Acoustic Code: 33200

- Receiver - Tracking Location (Year)
- ▲ 2014
- ⊕ Capture Location
- 2015
- ⊙ 2016

Receiver ID	7	11
Tracking Count	122	8638
Tracking Date Range	03/11/2014 to 28/03/2015	03/06/2014 to 12/02/2015
Depth Range	9m - 35m	4m - 36m
Average Depth	19.7m	20.6m



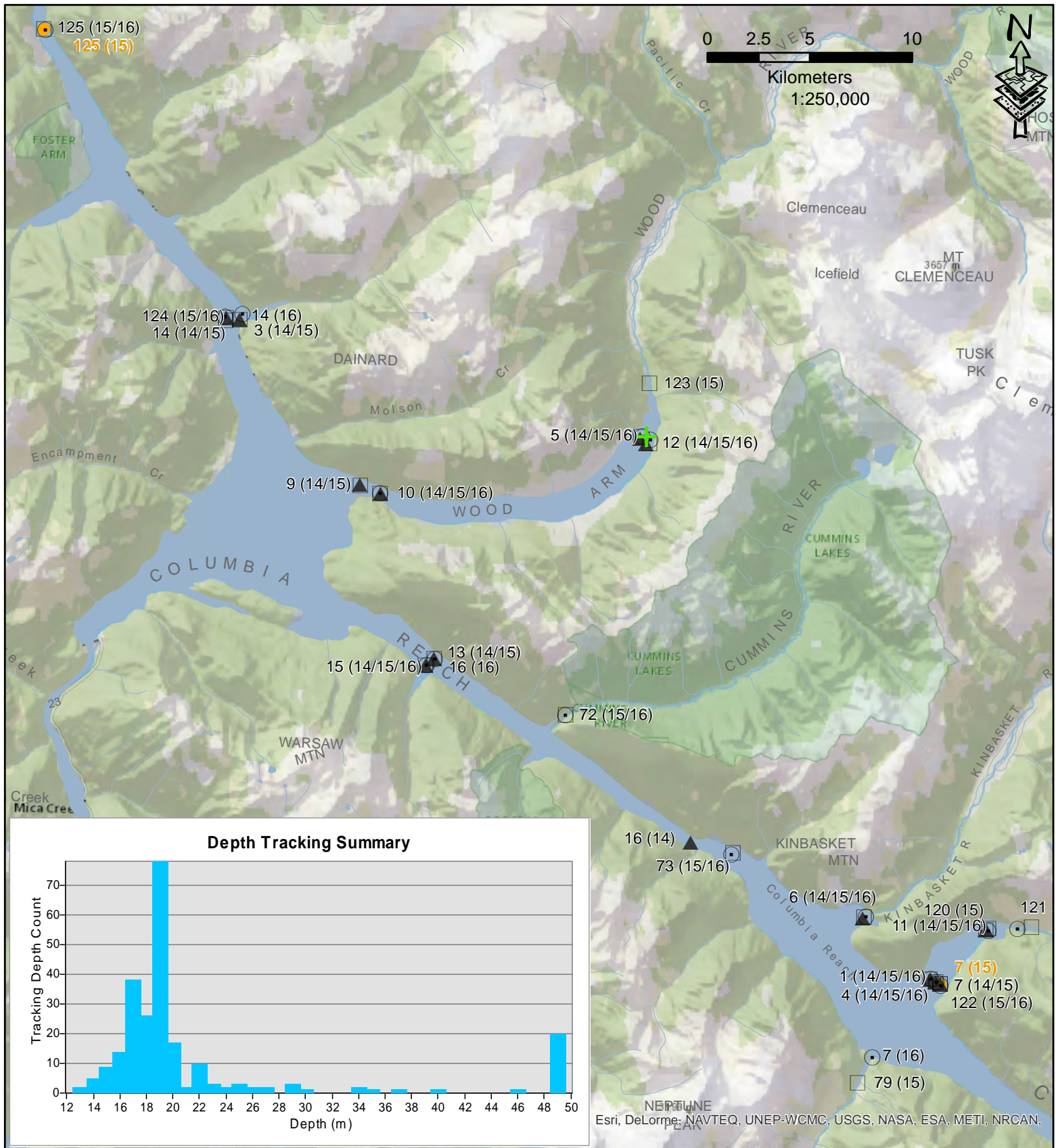


**Kinbasket Reservoir Burbot Tracking  
Acoustic Code: 33300**

- Receiver - Tracking Location (Year)
- ▲ 2014
- ⊕ Capture Location
- 2015
- ⊙ 2016

Receiver ID	1	4	6	7	11
Tracking Count	4	3	1102	356	5429
Tracking Date Range	15/05/2015 to 16/05/2015	16/05/2015 to 16/05/2015	18/05/2015 to 27/07/2015	09/07/2014 to 29/03/2015	15/07/2014 to 11/02/2015
Depth Range	37m - 43m	38m - 41m	8m - 48m	6m - 33m	3m - 35m
Average Depth	40.8m	39.0m	25.6m	19.1m	23.4m



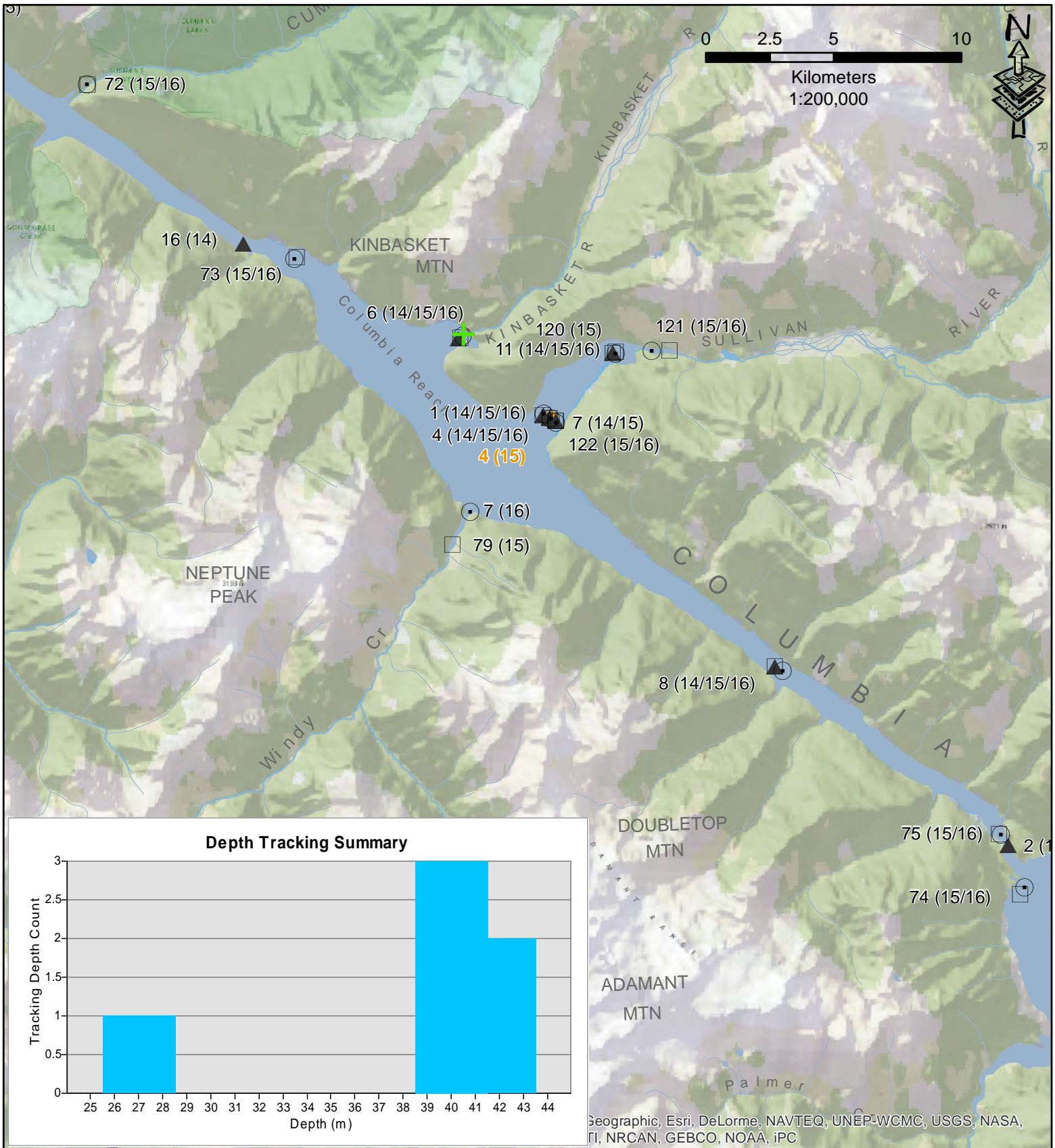


### Kinbasket Reservoir Burbot Tracking Acoustic Code: 33500

- Receiver - Tracking Location (Year)
- ▲ 2014
- 2015
- 2016
- + Capture Location

<b>Receiver ID</b>	7	125
<b>Tracking Count</b>	1	242
<b>Tracking Date Range</b>	31/03/2015 to 31/03/2015	21/07/2015 to 02/08/2015
<b>Depth Range</b>	25m - 25m	13m - 49m
<b>Average Depth</b>	25.m	21.7m





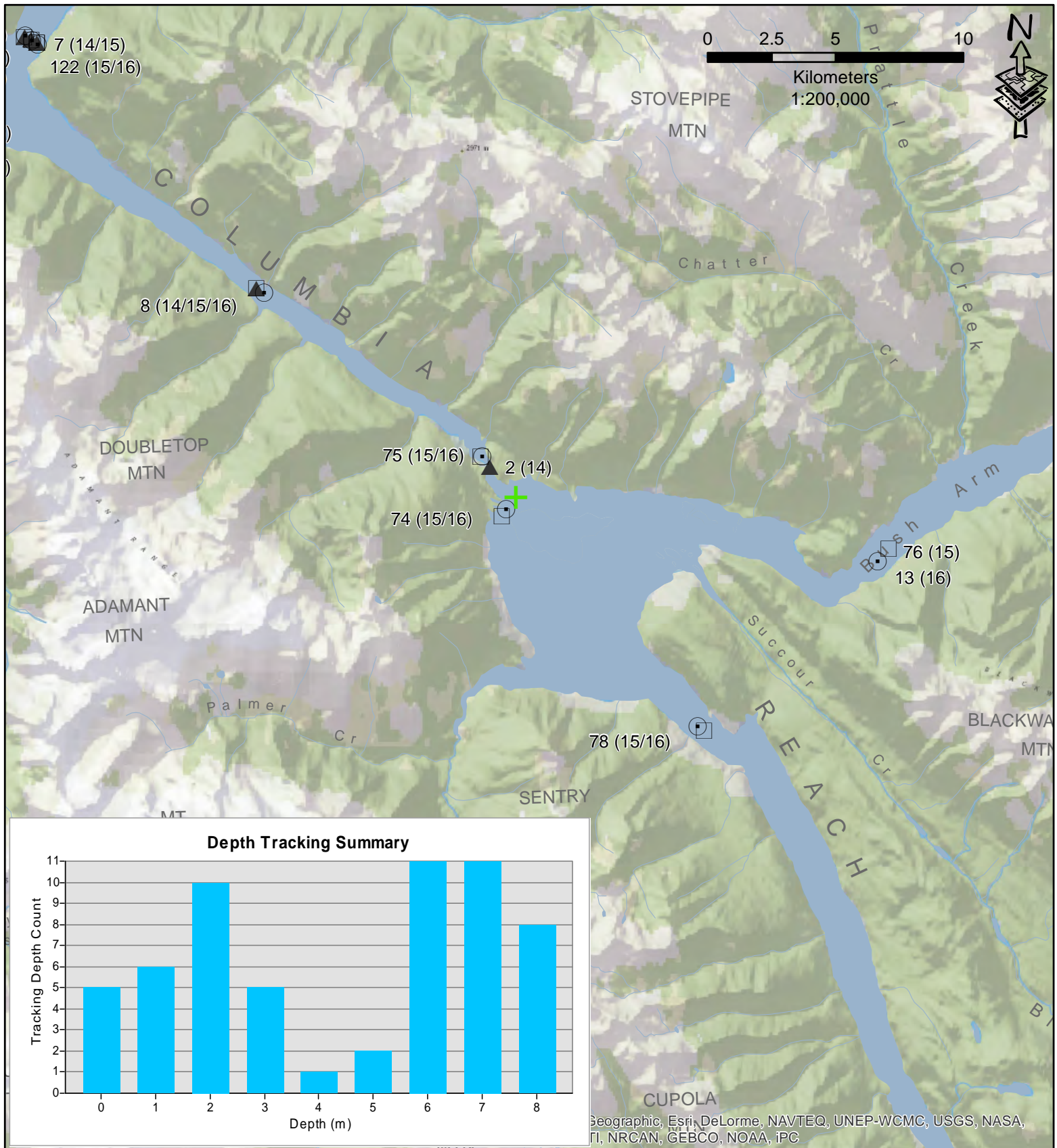
### Kinbasket Reservoir Burbot Tracking Acoustic Code: 33700

- Receiver - Tracking Location (Year)
- ▲ 2014
- ⊕ Capture Location
- 2015
- ⊙ 2016

Note: Missing location of receiver 113

<b>Receiver ID</b>	4	113
<b>Tracking Count</b>	1	6
<b>Tracking Date Range</b>	08/04/2016 to 08/04/2016	23/08/2015 to 17/09/2015
<b>Depth Range</b>	27m - 27m	40m - 42m
<b>Average Depth</b>	27.m	40.8m





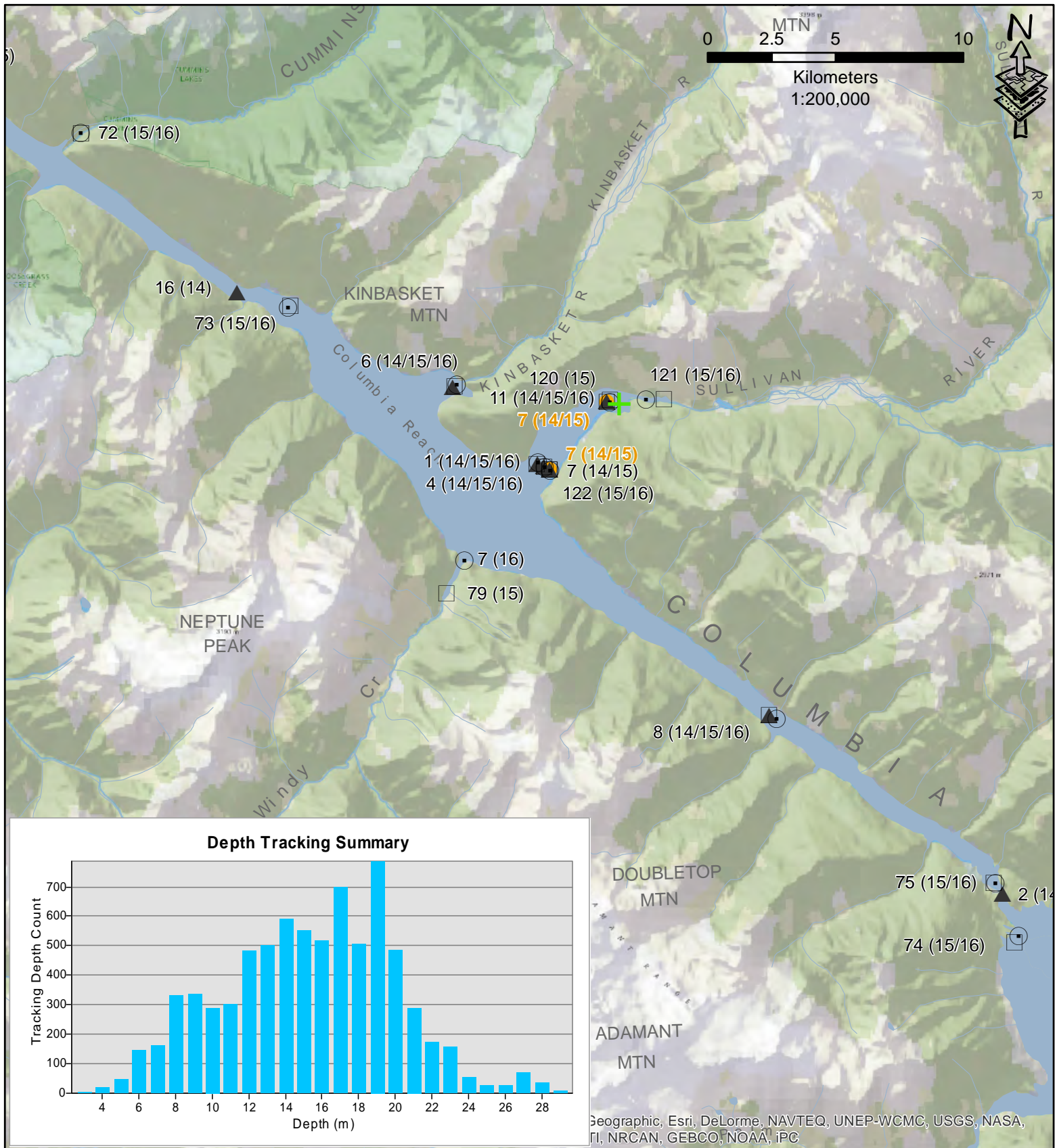
**Kinbasket Reservoir Burbot Tracking  
Acoustic Code: 33900**

- + Capture Location
- Receiver Location (Year)
  - ▲ 2014
  - 2015
  - ⊙ 2016

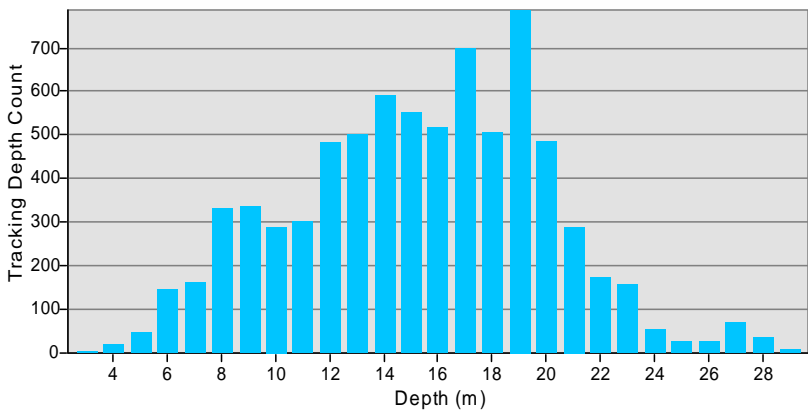
Note: Missing location of receiver 117

<b>Receiver ID</b>	117
<b>Tracking Count</b>	59
<b>Tracking Date Range</b>	23/09/2015 to 30/09/2015
<b>Depth Range</b>	0m - 8m
<b>Average Depth</b>	4.4m





**Depth Tracking Summary**



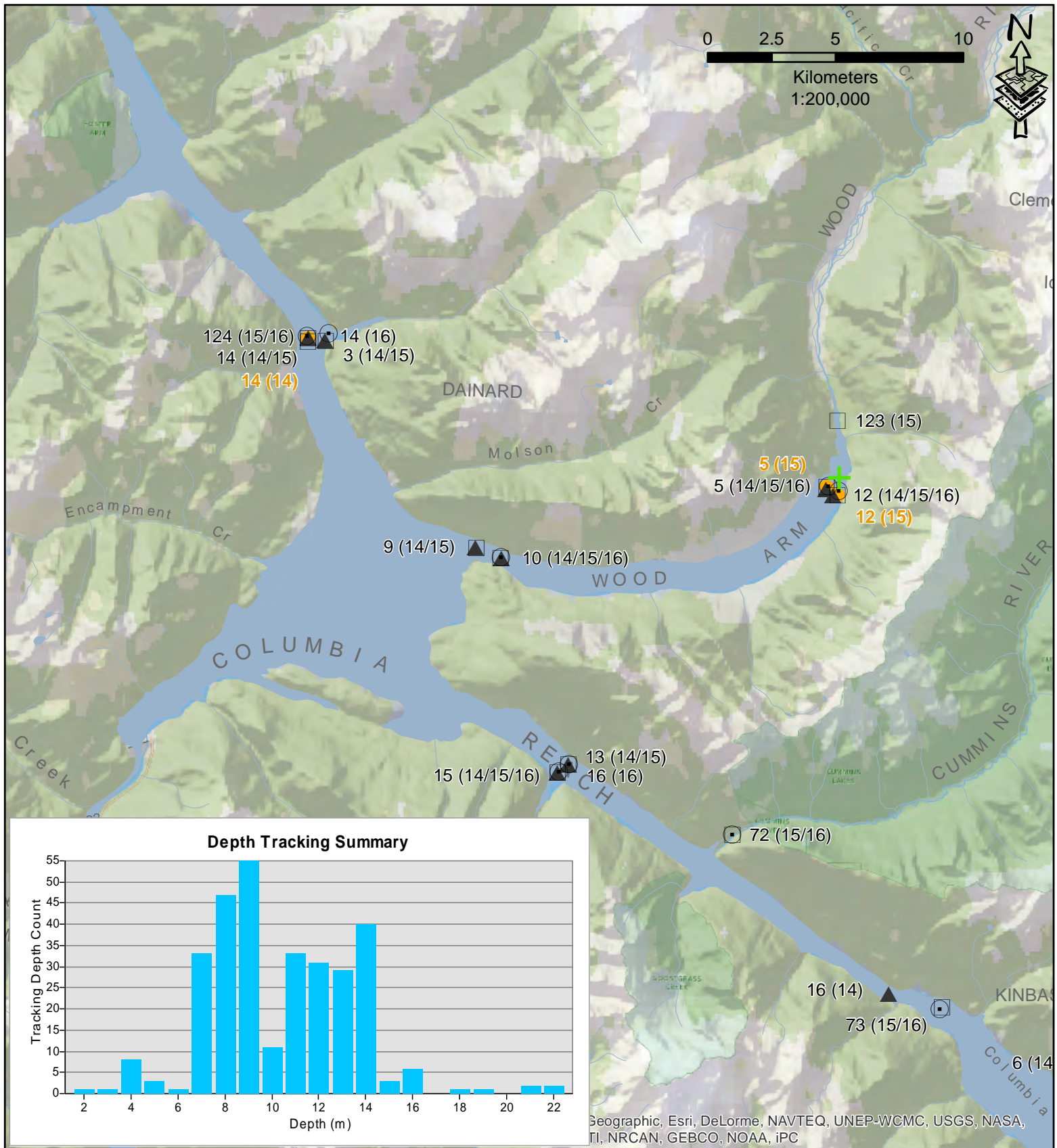
Geographic, Esri, DeLorme, NAVTEQ, UNEP-WCMC, USGS, NASA, FI, NRCAN, GEBCO, NOAA, IPC

**Kinbasket Reservoir Burbot Tracking  
Acoustic Code: 34000**

- Receiver - Tracking Location (Year)
- ▲ 2014
- ⊕ Capture Location
- 2015
- ⊙ 2016

Receiver ID	7	11
Tracking Count	20	7580
Tracking Date Range	05/12/2014 to 09/02/2015	05/06/2014 to 12/02/2015
Depth Range	11m - 26m	3m - 29m
Average Depth	18.2m	15.3m



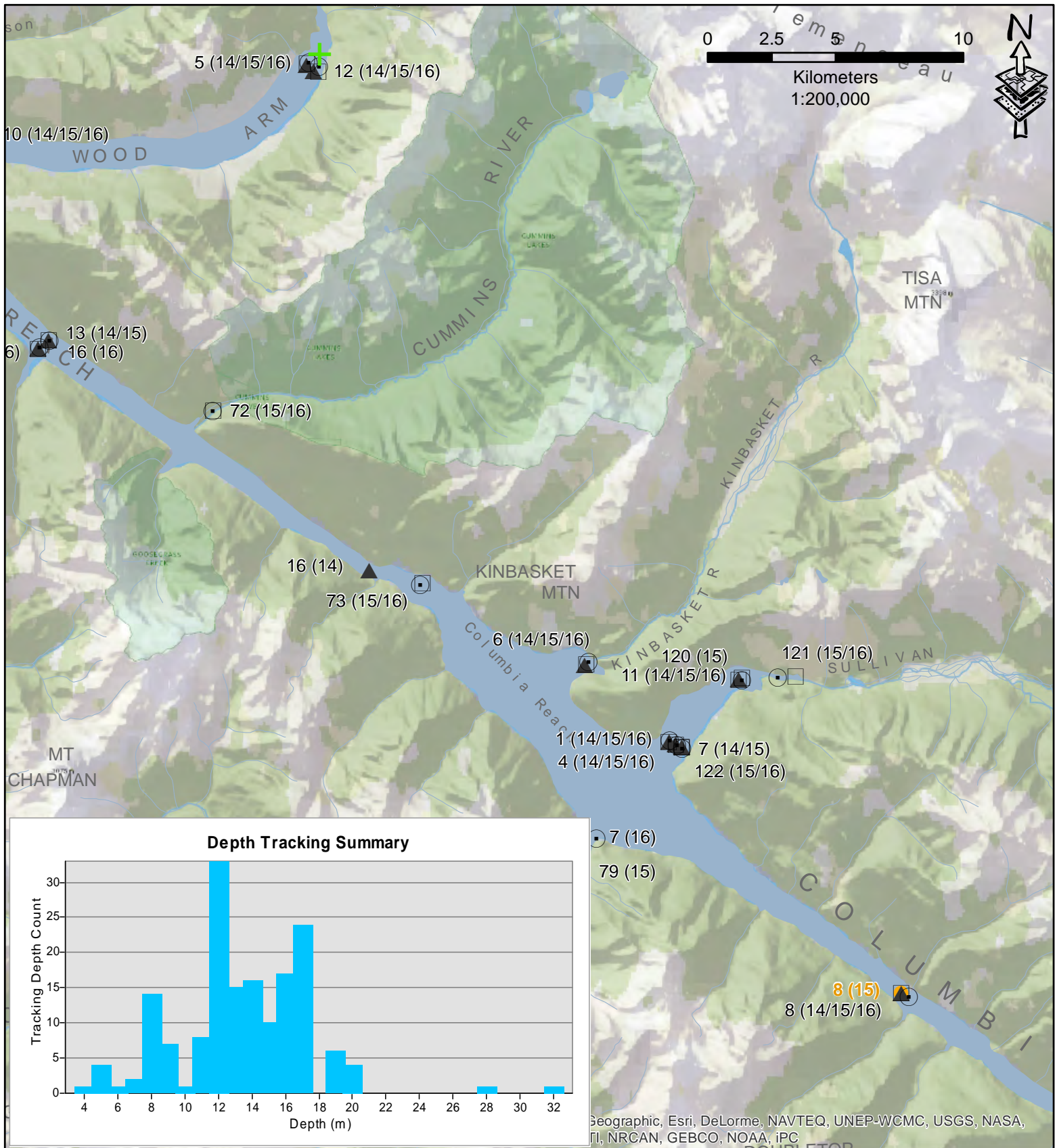


### Kinbasket Reservoir Burbot Tracking Acoustic Code: 34200

- Receiver - Tracking Location (Year)
- ▲ 2014
- ⊕ Capture Location
- 2015
- ⊙ 2016

Receiver ID	5	12	14
Tracking Count	72	230	6
Tracking Date Range	12/07/2015 to 02/10/2015	14/06/2015 to 15/10/2015	04/11/2014 to 04/11/2014
Depth Range	4m - 22m	2m - 21m	14m - 18m
Average Depth	9.9m	10.4m	15.7m





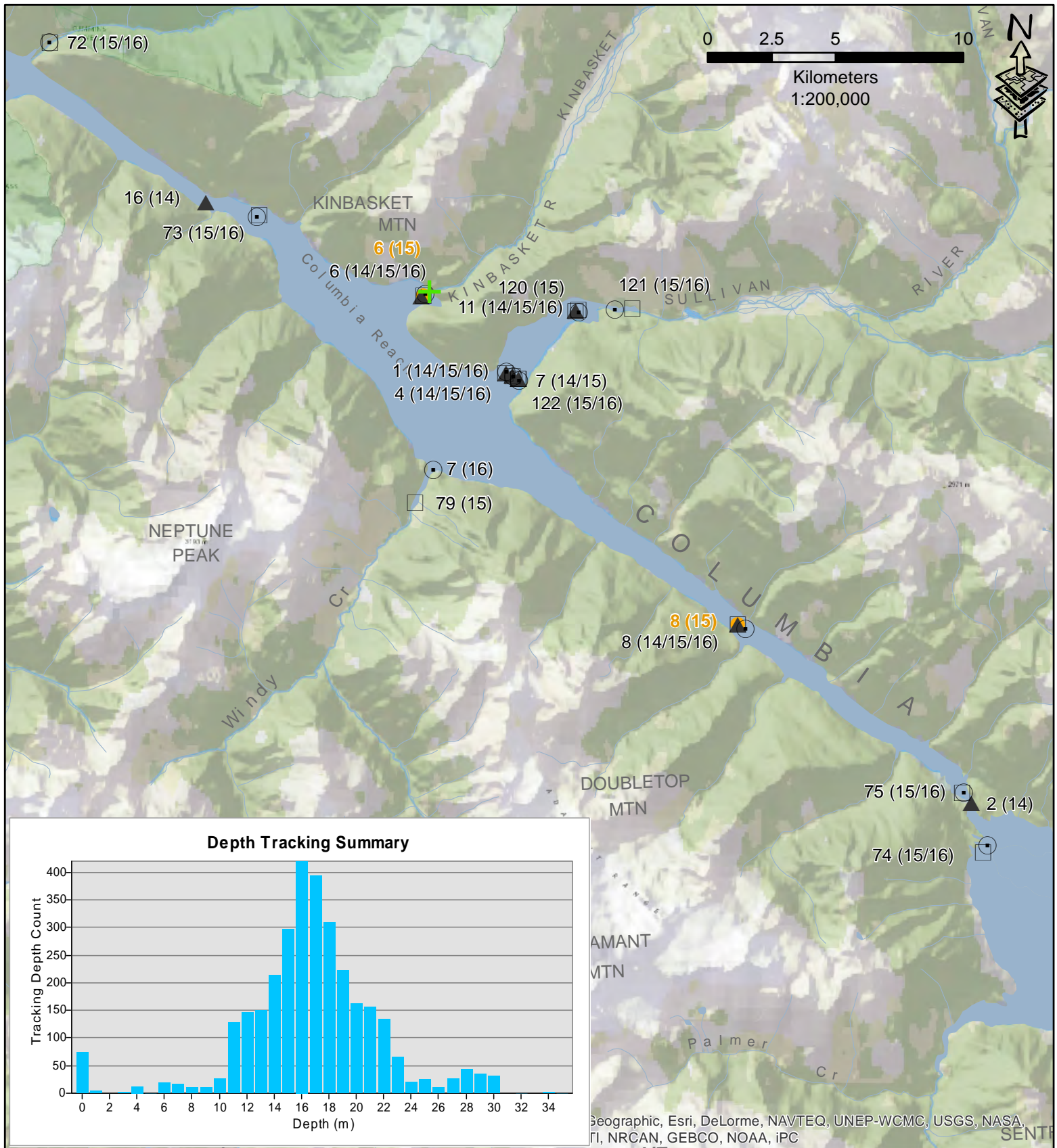
### Kinbasket Reservoir Burbot Tracking Acoustic Code: 34300

- Receiver - Tracking Location (Year)
- ▲ 2014
- ⊕ Capture Location
- 2015
- ⊙ 2016

Note: Missing location of receiver 113

<b>Receiver ID</b>	8	113
<b>Tracking Count</b>	140	25
<b>Tracking Date Range</b>	13/05/2015 to 30/08/2015	15/09/2015 to 16/09/2015
<b>Depth Range</b>	4m - 28m	14m - 32m
<b>Average Depth</b>	12.8m	17.2m



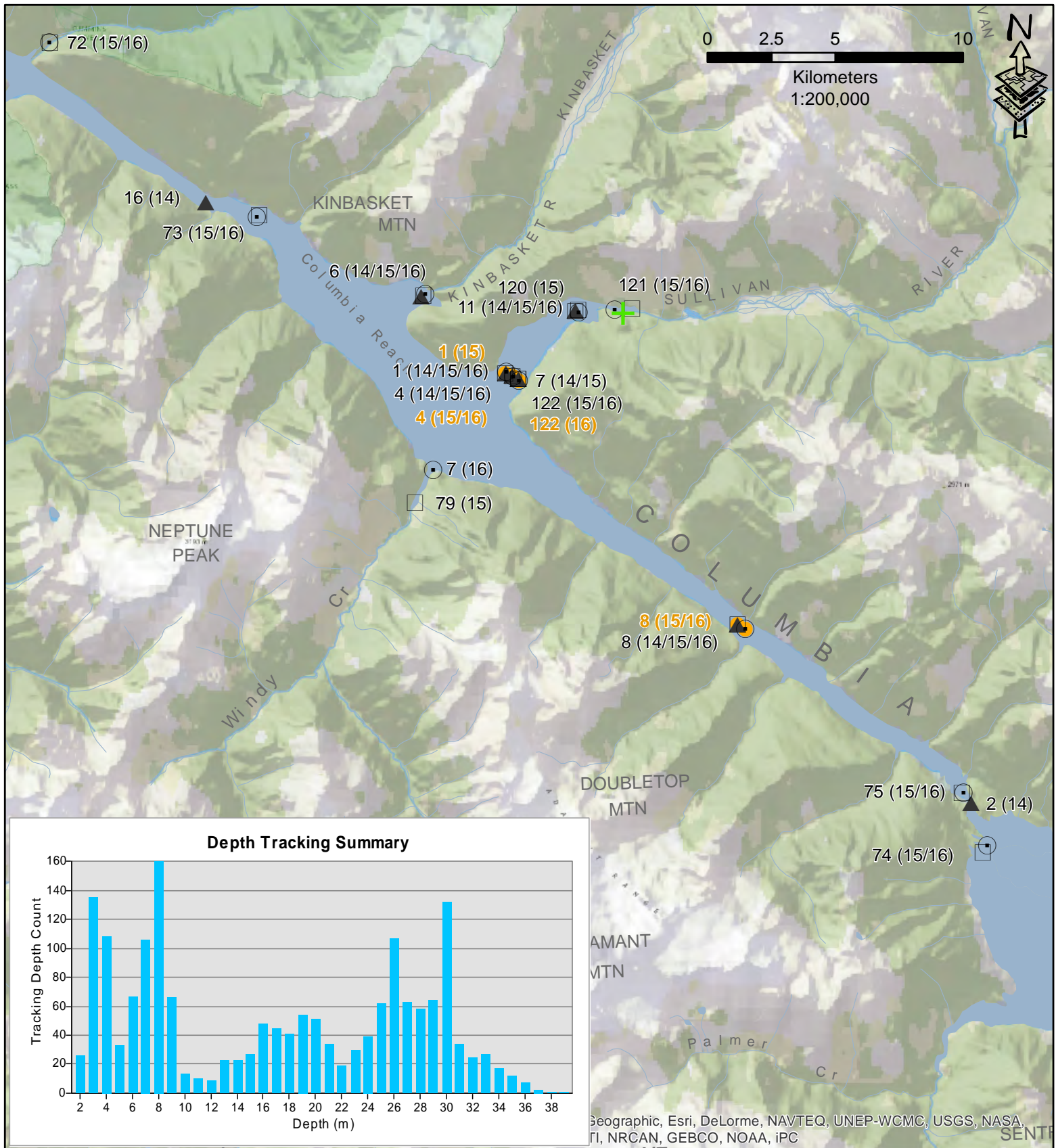


**Kinbasket Reservoir Burbot Tracking  
Acoustic Code: 34400**

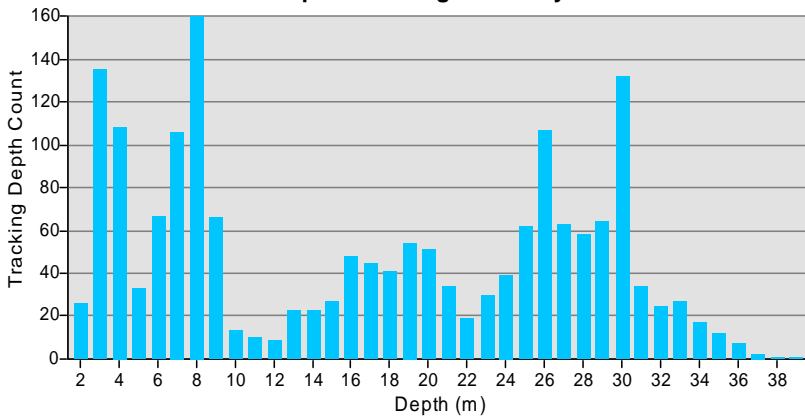
- Receiver - Tracking Location (Year)
- ▲ 2014
- ⊕ Capture Location
- 2015
- ⊙ 2016

Receiver ID	6	8
Tracking Count	3166	1
Tracking Date Range	12/05/2015 to 12/09/2015	14/11/2015 to 14/11/2015
Depth Range	0m - 35m	5m - 5m
Average Depth	16.7m	5.m





**Depth Tracking Summary**



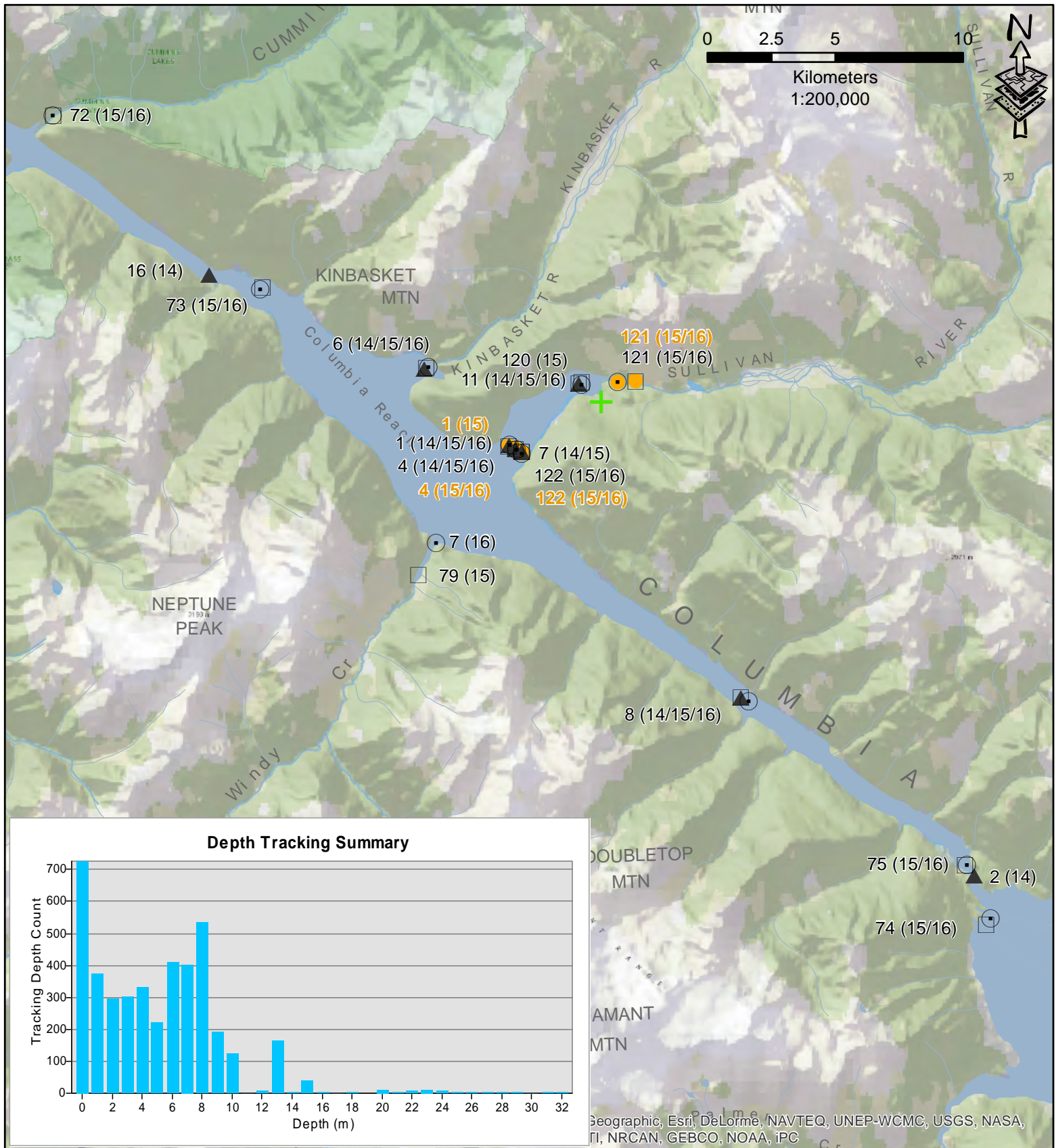
- Receiver - Tracking Location (Year)
- ▲ 2014
- 2015
- ⊙ 2016
- ⊕ Capture Location

**Kinbasket Reservoir Burbot Tracking  
Acoustic Code: 34600**

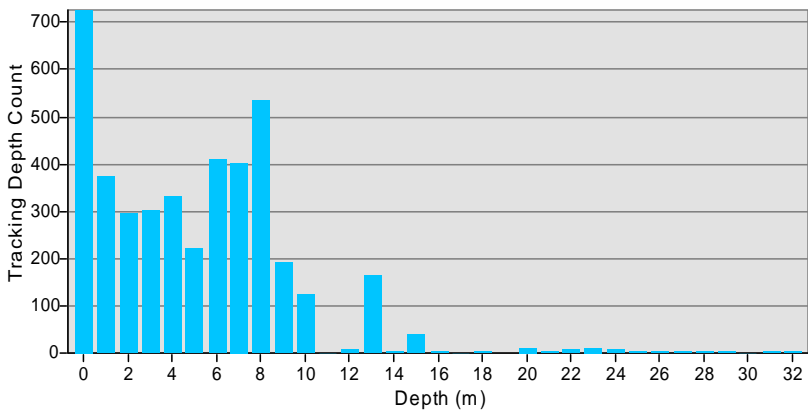
Note: Missing location receiver 114, 115, 116, 118

Receiver ID	1	4	8	114	115	116	118	122
Tracking Count	14	292	203	146	160	708	2	253
Tracking Date Range	22/12/2015 to 23/12/2015	27/05/2015 to 11/04/2016	28/05/2015 to 27/04/2016	19/12/2015 to 28/04/2016	20/12/2015 to 28/04/2016	14/09/2015 to 15/12/2015	01/05/2016 to 01/05/2016	04/04/2016 to 11/04/2016
Depth Range	16m - 27m	9m - 39m	12m - 38m	6m - 21m	6m - 30m	2m - 11m	6m - 6m	22m - 36m
Average Depth	20.1m	27.7m	23.2m	16.9m	19.8m	5.9m	6.0m	28.4m





**Depth Tracking Summary**

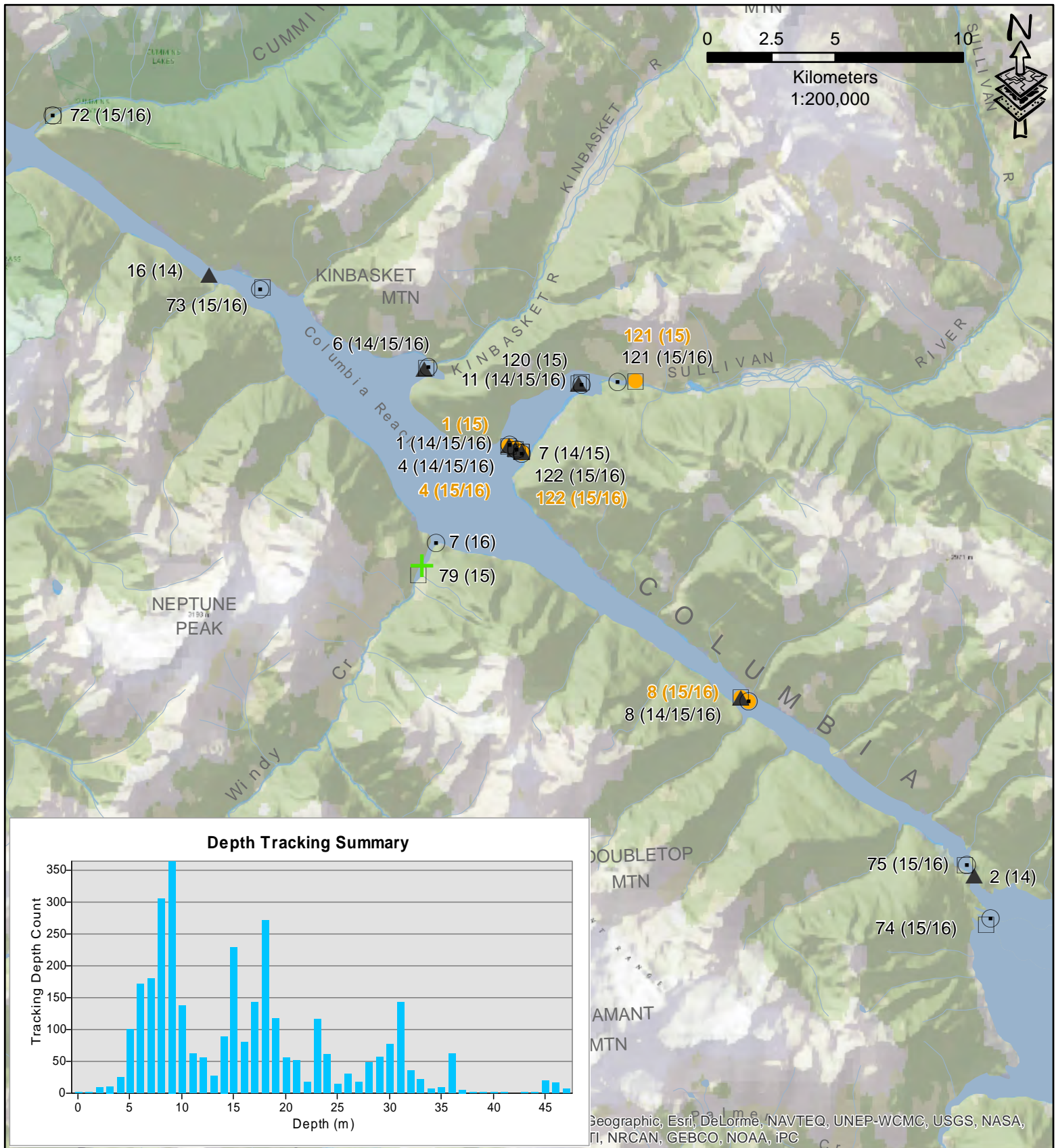


**Kinbasket Reservoir Burbot Tracking  
Acoustic Code: 34700**

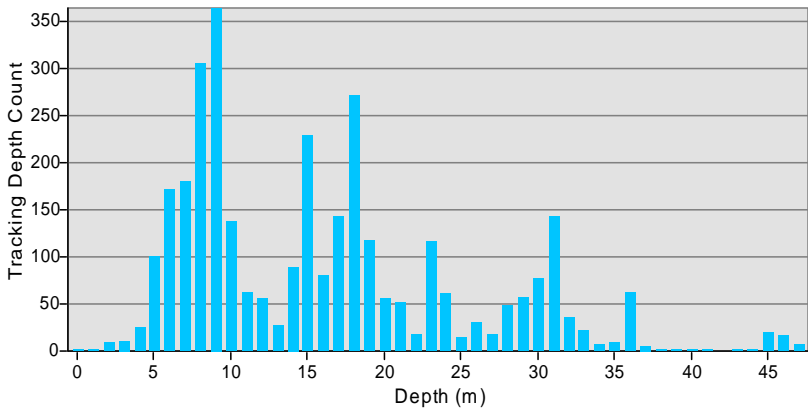
- Receiver - Tracking Location (Year)
- ▲ 2014
- + Capture Location
- 2015
- ◉ 2016

Receiver ID	1	4	121	122
Tracking Count	72	200	3877	42
Tracking Date Range	06/11/2015 to 18/12/2015	06/11/2015 to 30/03/2016	08/08/2015 to 14/01/2016	06/11/2015 to 30/03/2016
Depth Range	6m - 25m	5m - 32m	0m - 10m	4m - 32m
Average Depth	13.2m	14.4m	4.3m	20.1m





**Depth Tracking Summary**



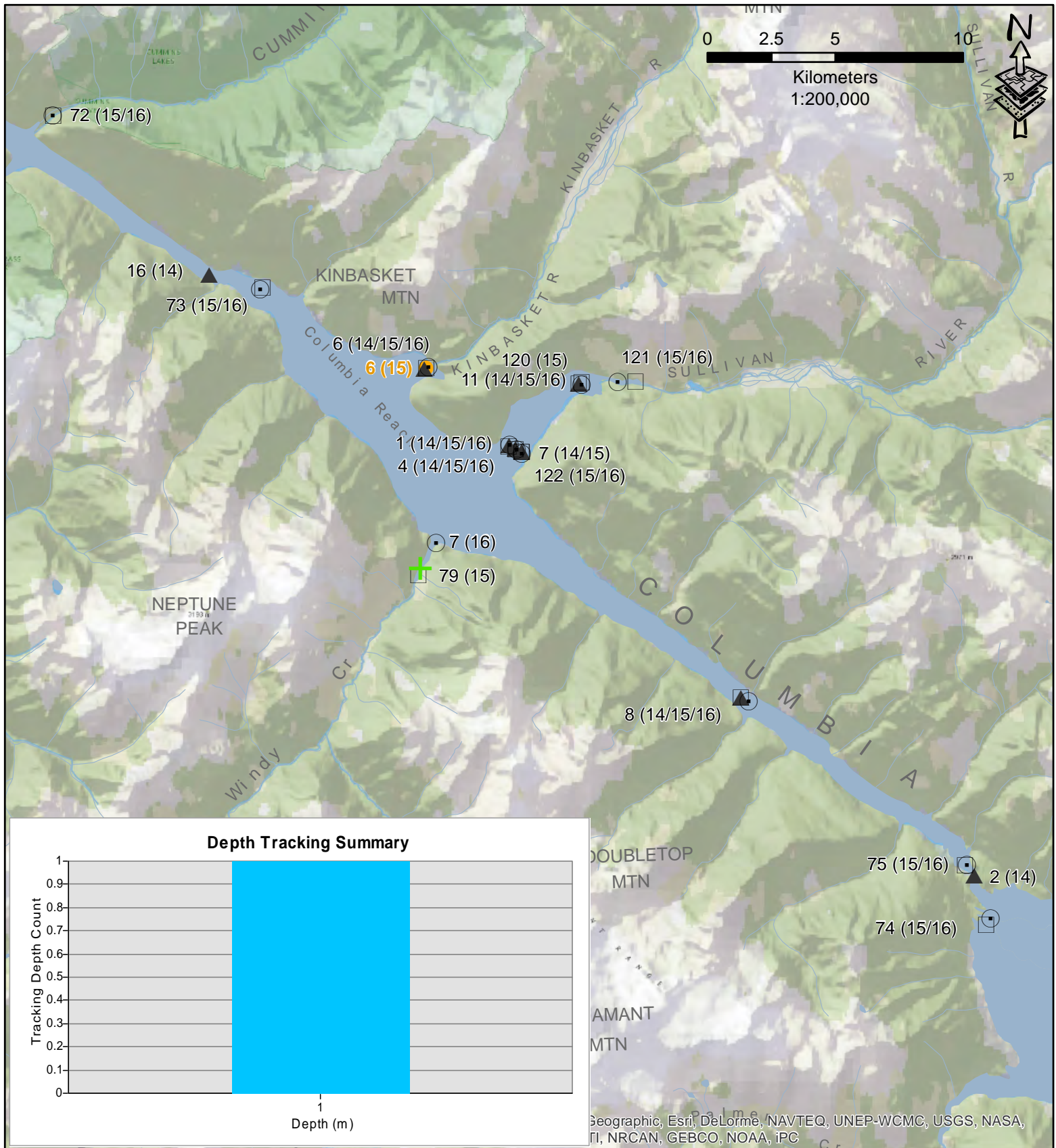
- Receiver - Tracking Location (Year)
- ▲ 2014
- ⊕ Capture Location
- 2015
- 2016

**Kinbasket Reservoir Burbot Tracking  
Acoustic Code: 35000**

Note: Missing location receiver 113, 115

Receiver ID	1	4	8	113	115	121	122
Tracking Count	302	438	826	10	112	1264	308
Tracking Date Range	29/06/2015 to 05/11/2015	29/06/2015 to 26/04/2016	09/11/2015 to 10/04/2016	12/04/2016 to 28/04/2016	17/12/2015 to 04/04/2016	04/08/2015 to 13/10/2015	07/10/2015 to 24/04/2016
Depth Range	8m - 47m	7m - 47m	12m - 43m	22m - 41m	15m - 23m	0m - 11m	8m - 47m
Average Depth	21.7m	22.6m	21.5m	33.2m	18.2m	7.7m	20.2m



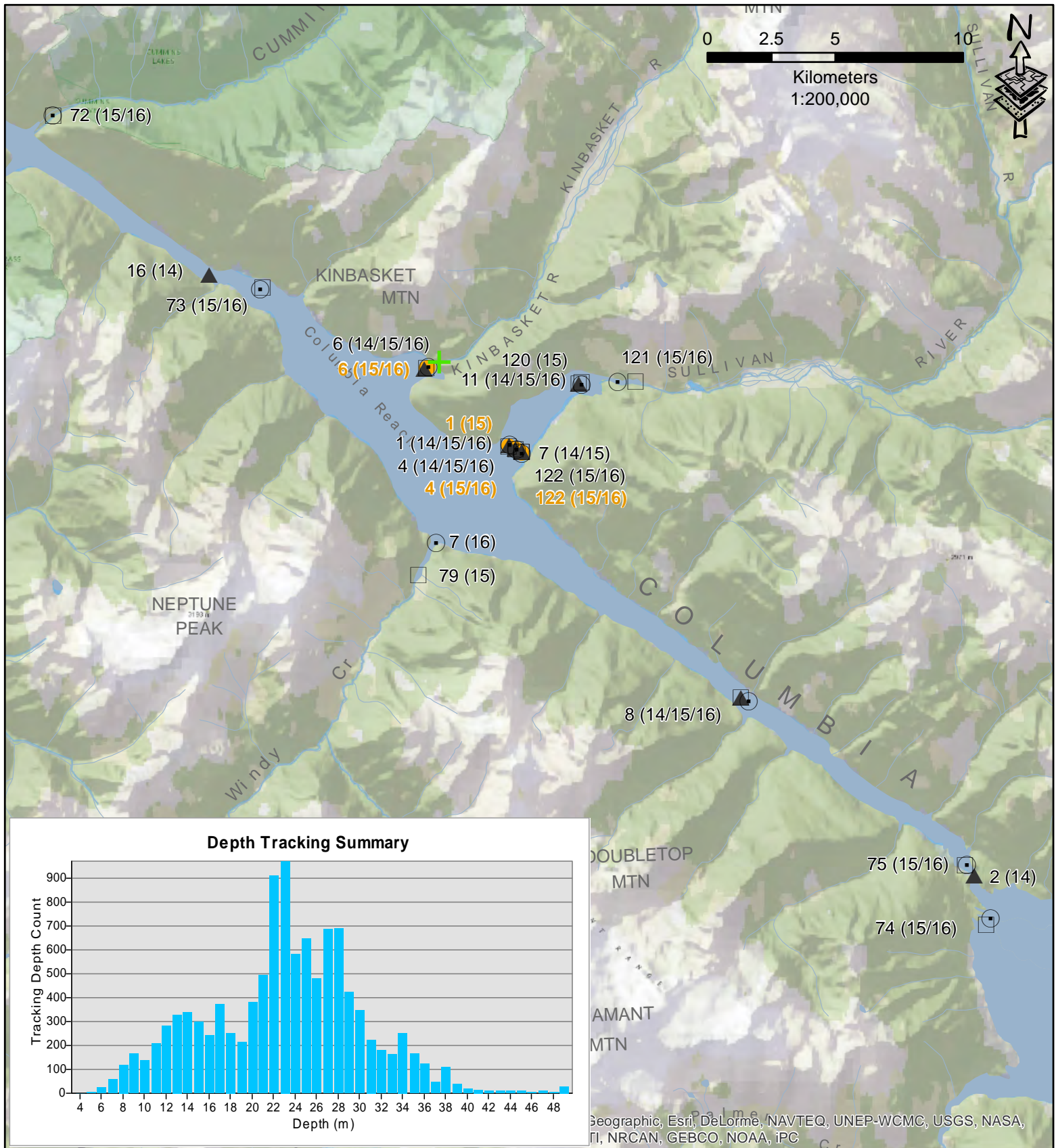


### Kinbasket Reservoir Burbot Tracking Acoustic Code: 35100

- Receiver - Tracking Location (Year)
- ▲ 2014
- ⊕ Capture Location
- 2015
- ⊙ 2016

Receiver ID	6
Tracking Count	1
Tracking Date Range	07/10/2015 to 07/10/2015
Depth Range	1m - 1m
Average Depth	1.m





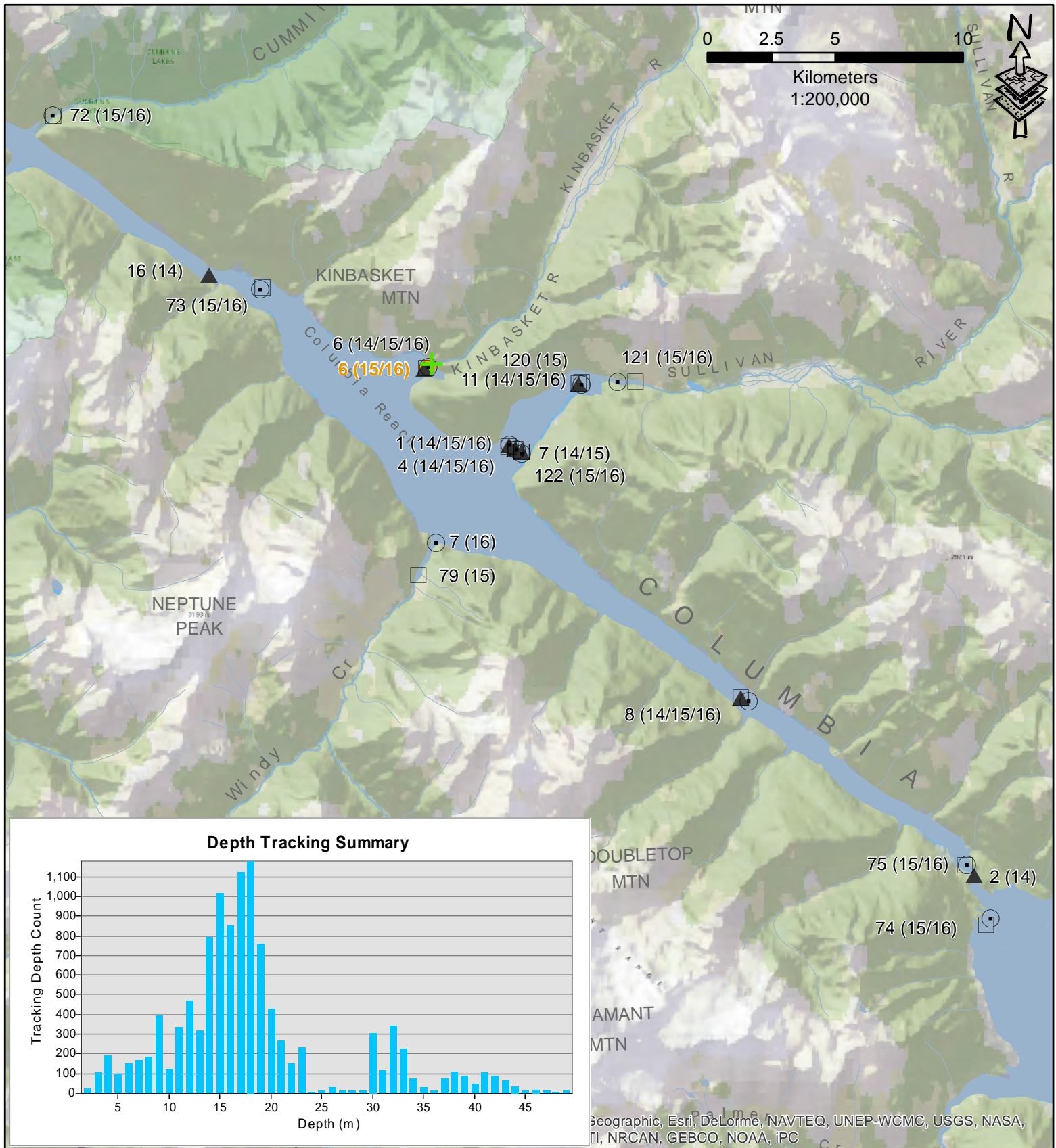
### Kinbasket Reservoir Burbot Tracking Acoustic Code: 35200

Note: Missing location receiver 113

- Receiver - Tracking Location (Year)
- ▲ 2014
- ⊕ Capture Location
- 2015
- ⊙ 2016

Receiver ID	1	4	6	113	122
Tracking Count	598	481	9757	68	201
Tracking Date Range	13/05/2015 to 24/12/2015	13/05/2015 to 23/04/2016	26/05/2015 to 09/01/2016	07/11/2015 to 02/05/2016	24/12/2015 to 19/04/2016
Depth Range	6m - 49m	6m - 45m	4m - 49m	12m - 48m	25m - 42m
Average Depth	12.4m	19.m	23.8m	22.6m	29.m





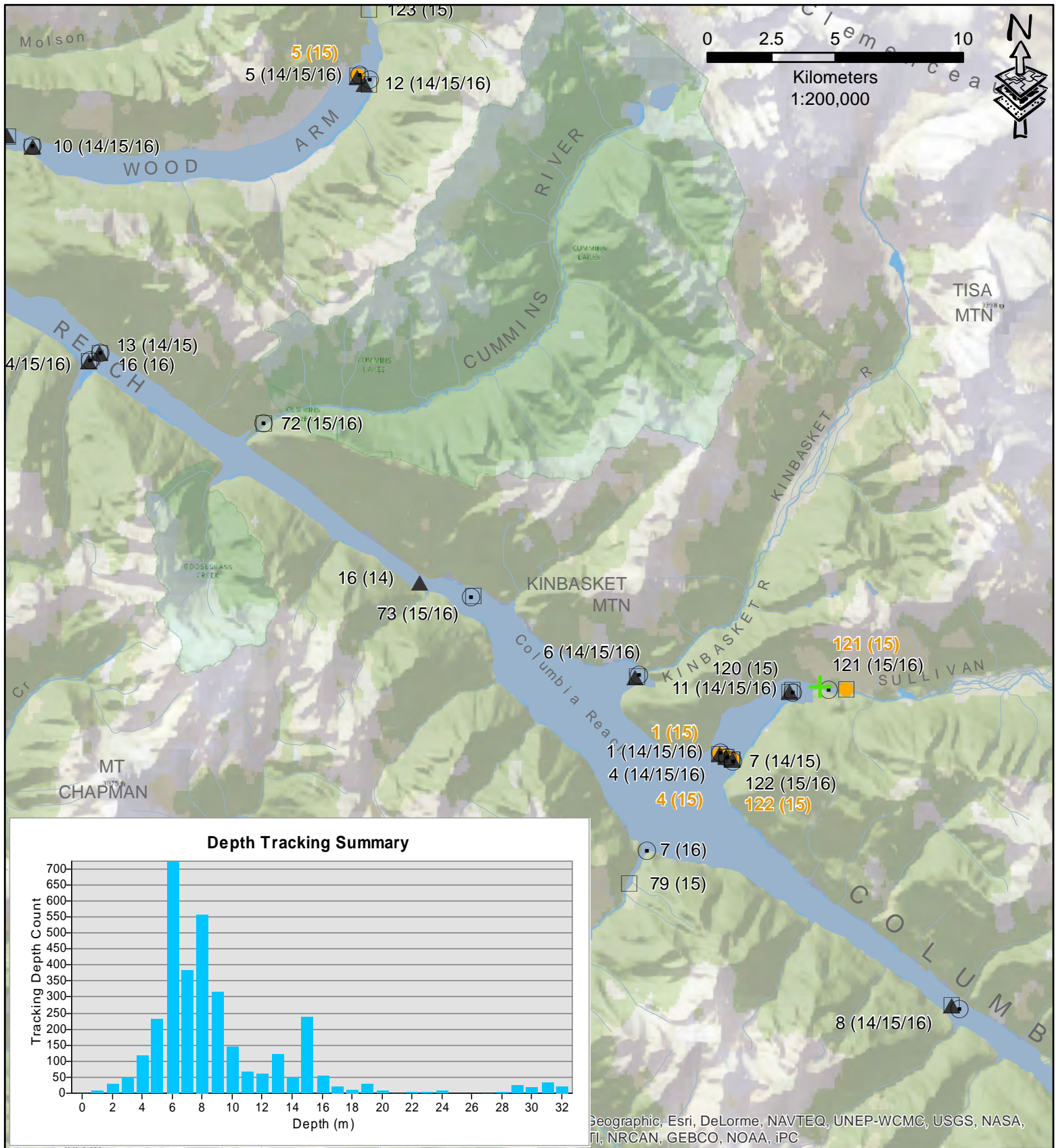
### Kinbasket Reservoir Burbot Tracking Acoustic Code: 35300

- Receiver - Tracking Location (Year)
- ▲ 2014
- ⊕ Capture Location
- 2015
- ⊙ 2016

Note: Missing location receiver 113

Receiver ID	6	113
Tracking Count	8118	3077
Tracking Date Range	16/05/2015 to 10/01/2016	30/10/2015 to 02/05/2016
Depth Range	2m - 47m	6m - 49m
Average Depth	18.2m	18.7m



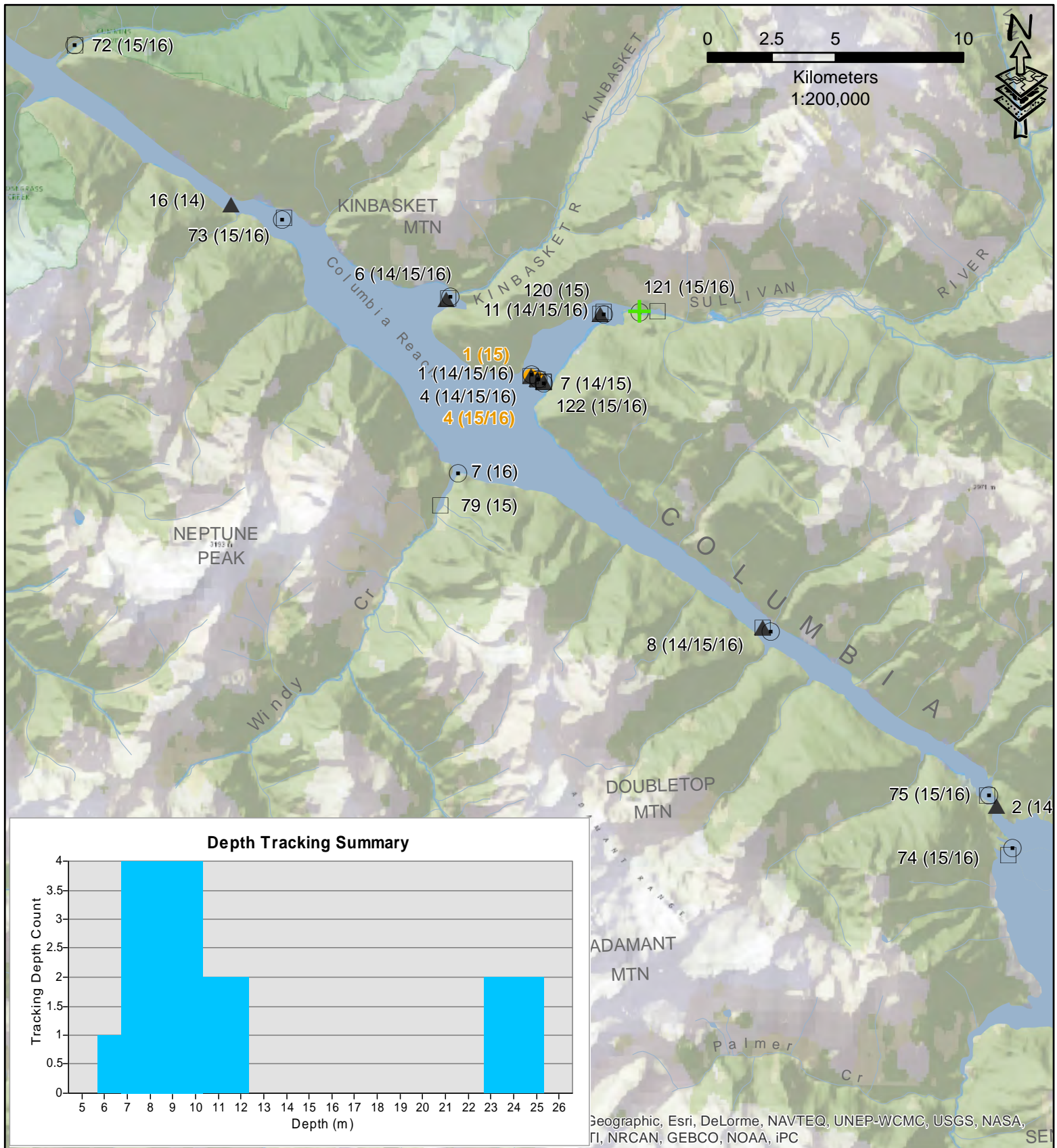


- Receiver - Tracking Location (Year)
- ⊕ Capture Location
- ▲ 2014
- 2015
- 2016

### Kinbasket Reservoir Burbot Tracking Acoustic Code: 35400

Receiver ID	1	4	5	121	122
Tracking Count	284	688	1	2265	98
Tracking Date Range	21/05/2015 to 07/08/2015	20/05/2015 to 07/08/2015	05/11/2015 to 05/11/2015	10/08/2015 to 16/10/2015	22/07/2015 to 07/08/2015
Depth Range	4m - 32m	4m - 32m	5m - 5m	0m - 11m	3m - 19m
Average Depth	14.9m	13.8m	5.m	6.9m	11.7m



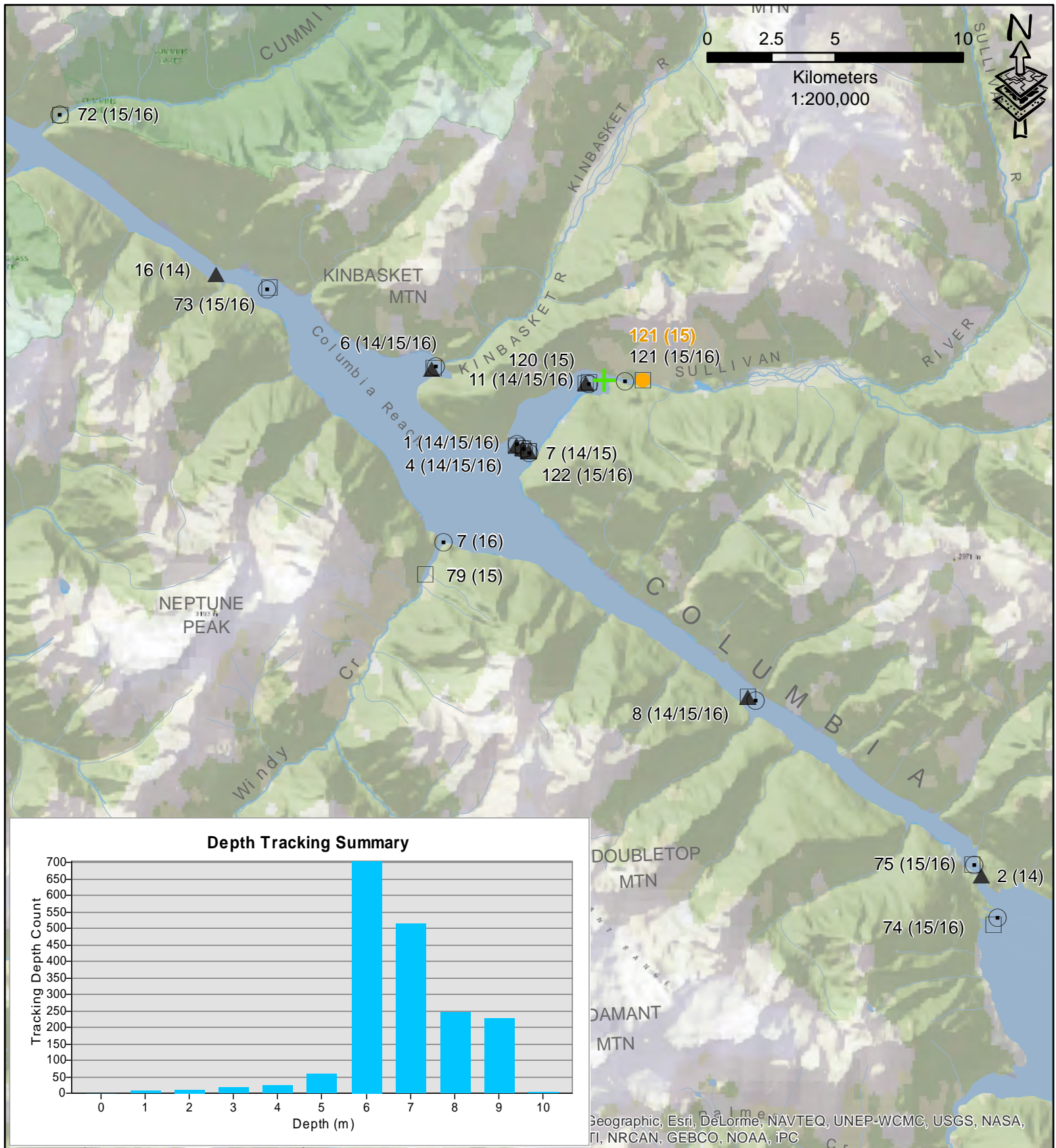


### Kinbasket Reservoir Burbot Tracking Acoustic Code: 35500

- Receiver - Tracking Location (Year)
- ▲ 2014
- ⊕ Capture Location
- 2015
- ⊙ 2016

<b>Receiver ID</b>	1	4
<b>Tracking Count</b>	6	7
<b>Tracking Date Range</b>	05/06/2015 to 05/06/2015	05/06/2015 to 19/03/2016
<b>Depth Range</b>	7m - 9m	8m - 24m
<b>Average Depth</b>	8.2m	13.7m



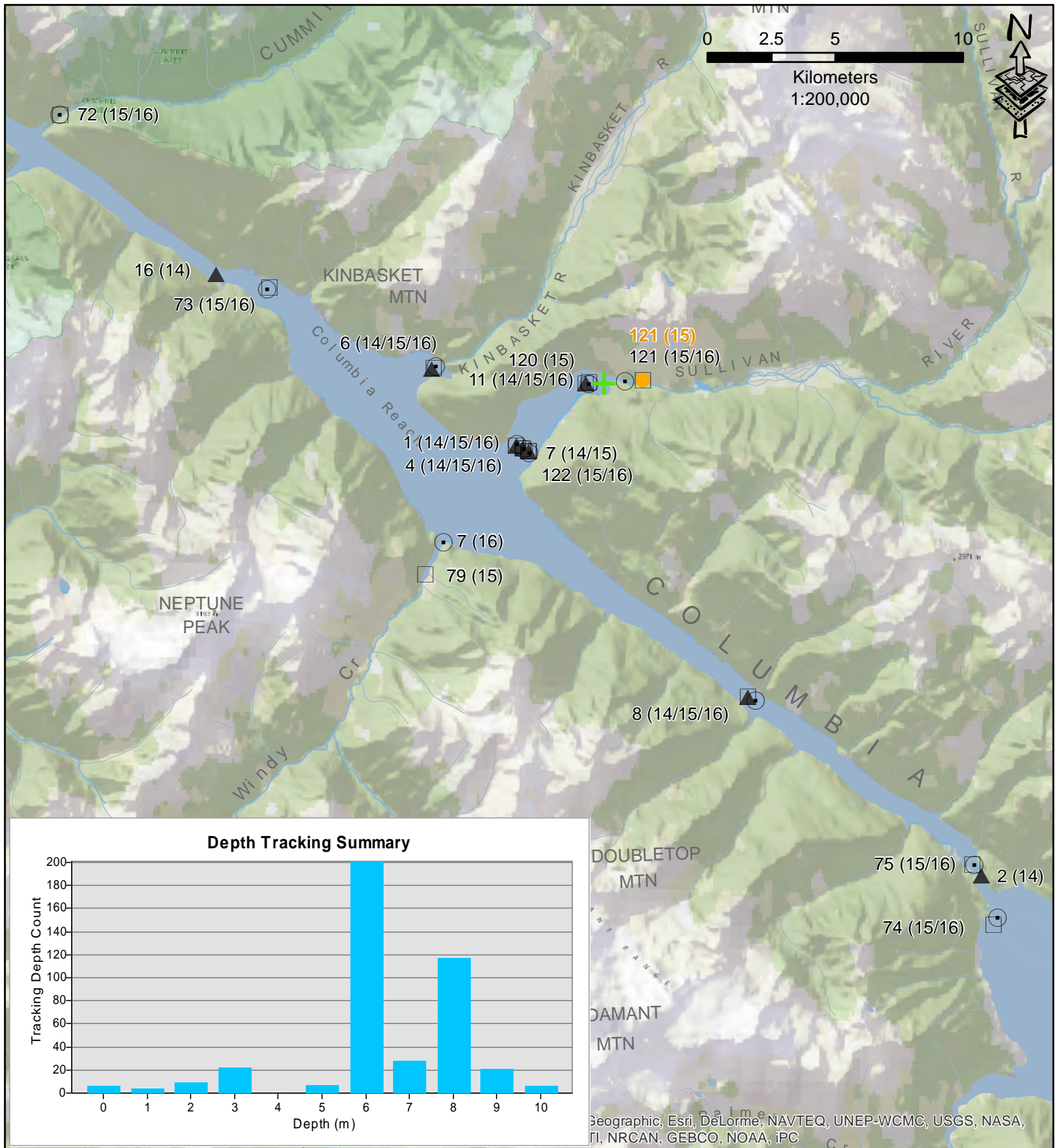


**Kinbasket Reservoir Burbot Tracking**  
**Acoustic Code: 35600**

- Receiver - Tracking Location (Year)
- ▲ 2014
- ⊕ Capture Location
- 2015
- ⊙ 2016

<b>Receiver ID</b>	121
<b>Tracking Count</b>	1812
<b>Tracking Date Range</b>	29/07/2015 to 10/11/2015
<b>Depth Range</b>	0m - 10m
<b>Average Depth</b>	6.8m



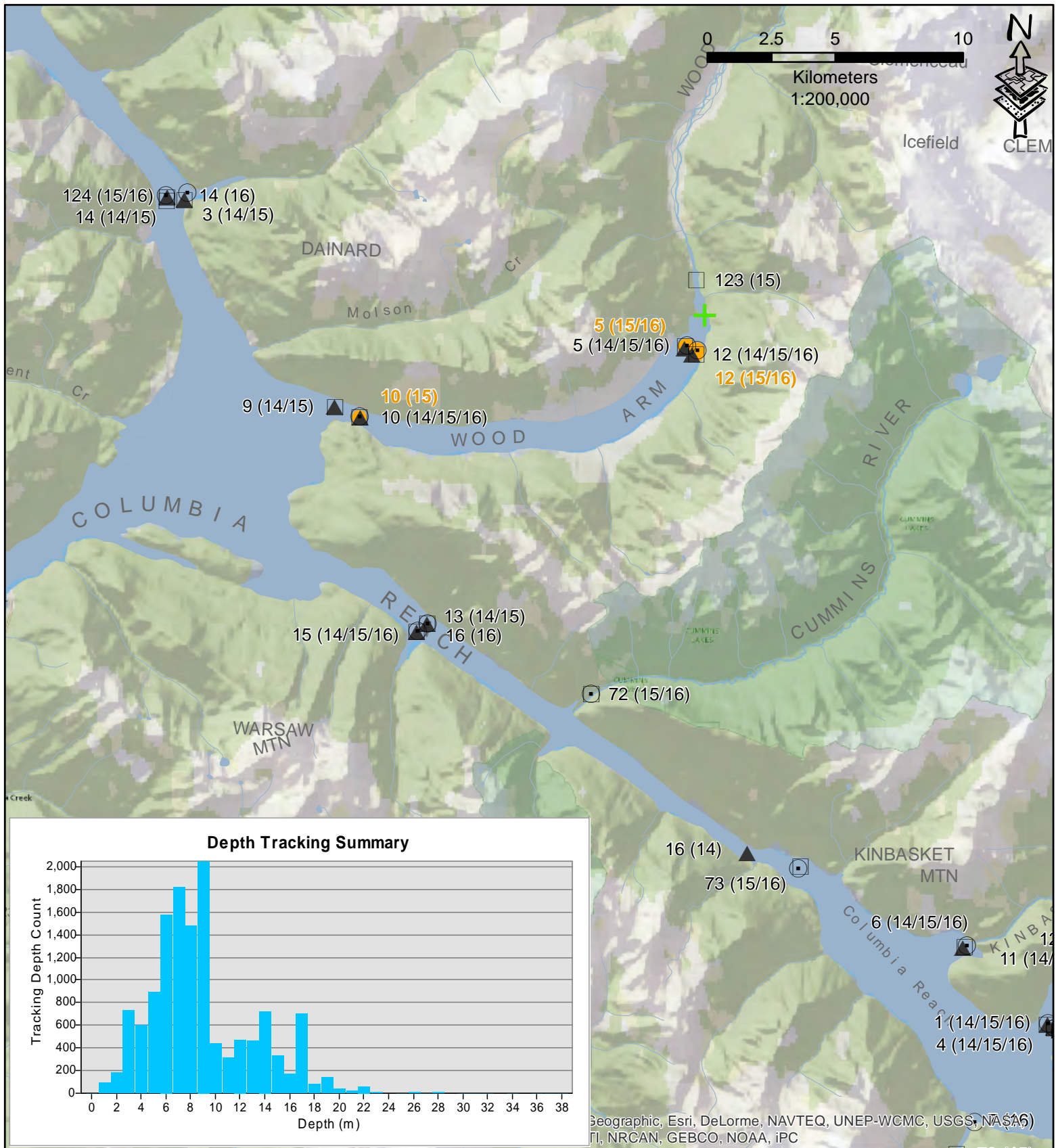


### Kinbasket Reservoir Burbot Tracking Acoustic Code: 35700

- Receiver - Tracking Location (Year)
- Receiver - Tracking Location (Year)
- +
- ▲ 2014
- 2015
- 2016

<b>Receiver ID</b>	121
<b>Tracking Count</b>	421
<b>Tracking Date Range</b>	22/07/2015 to 02/10/2015
<b>Depth Range</b>	0m - 10m
<b>Average Depth</b>	6.4m



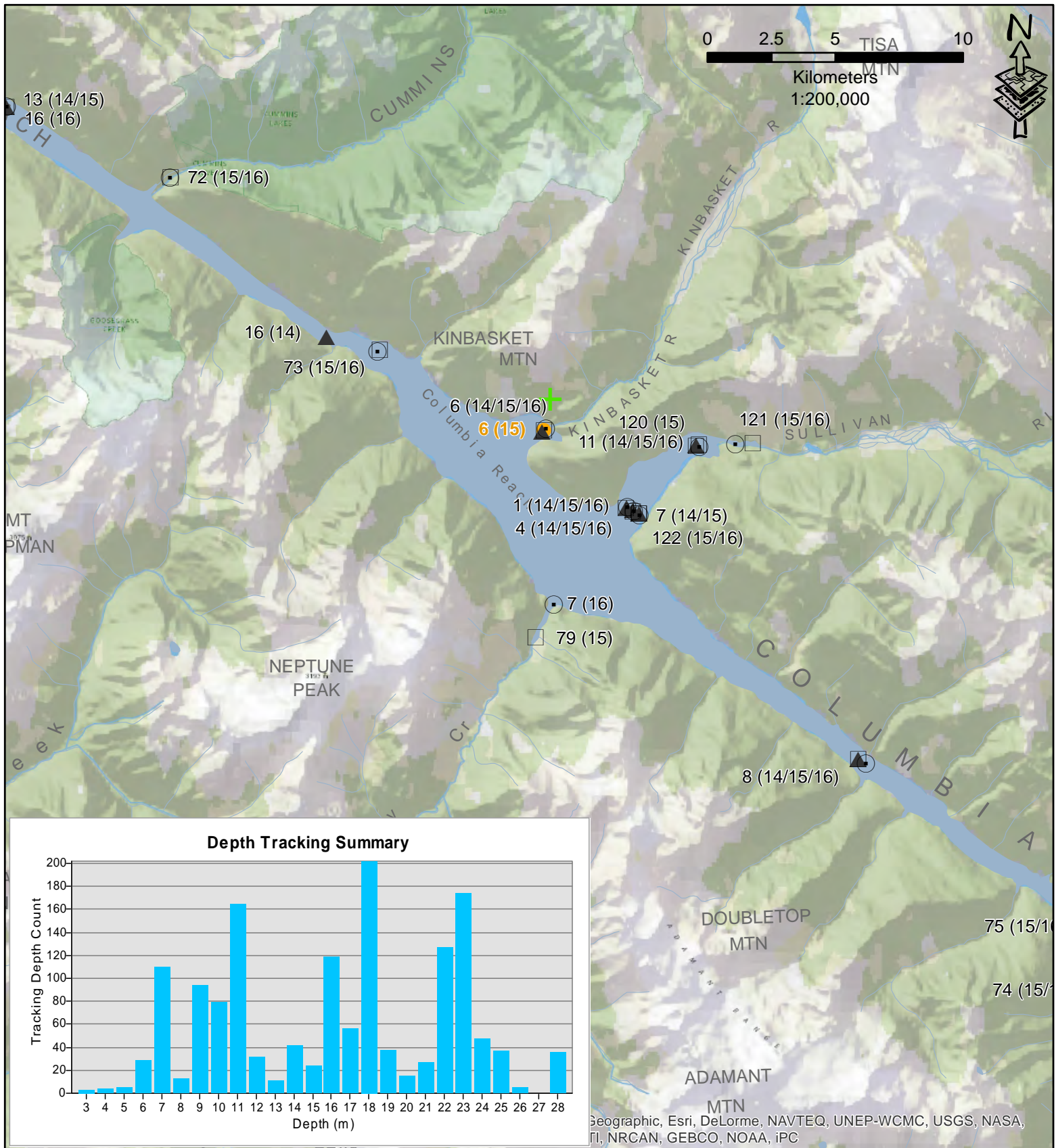


### Kinbasket Reservoir Burbot Tracking Acoustic Code: 35800

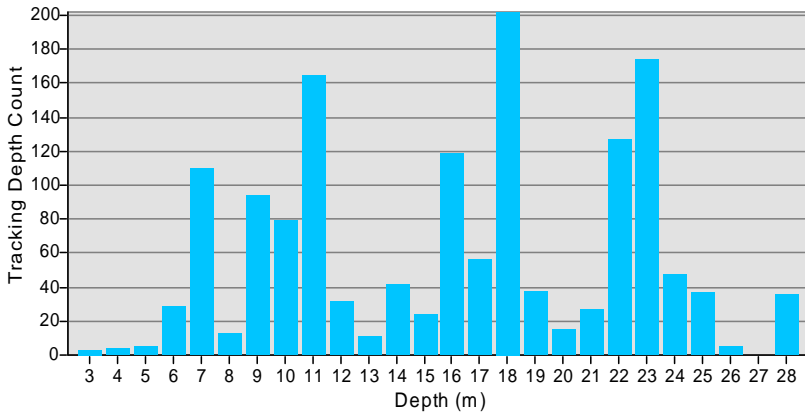
- Receiver - Tracking Location (Year)
- ▲ 2014
- ⊕ Capture Location
- 2015
- ⊙ 2016

Receiver ID	5	10	12
Tracking Count	6058	71	7313
Tracking Date Range	19/05/2015 to 01/05/2016	12/11/2015 to 14/11/2015	17/05/2015 to 20/03/2016
Depth Range	0m - 25m	7m - 38m	1m - 31m
Average Depth	8.3m	19.2m	9.3m





**Depth Tracking Summary**

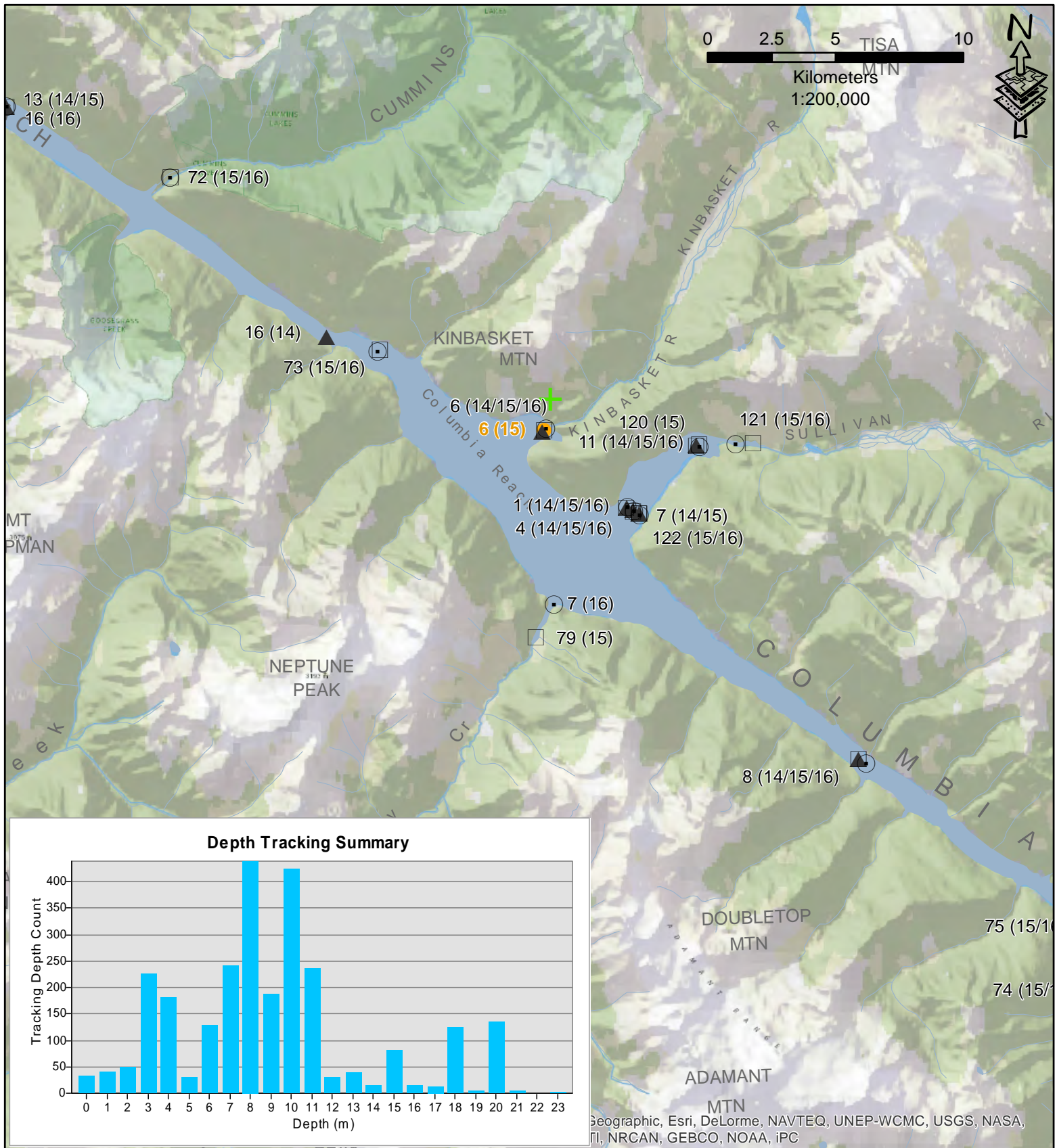


**Kinbasket Reservoir Burbot Tracking  
Acoustic Code: 35900**

- Receiver - Tracking Location (Year)
- ▲ 2014
- ⊕ Capture Location
- 2015
- ⊙ 2016

<b>Receiver ID</b>	6
<b>Tracking Count</b>	1494
<b>Tracking Date Range</b>	12/05/2015 to 18/06/2015
<b>Depth Range</b>	3m - 28m
<b>Average Depth</b>	16.1m



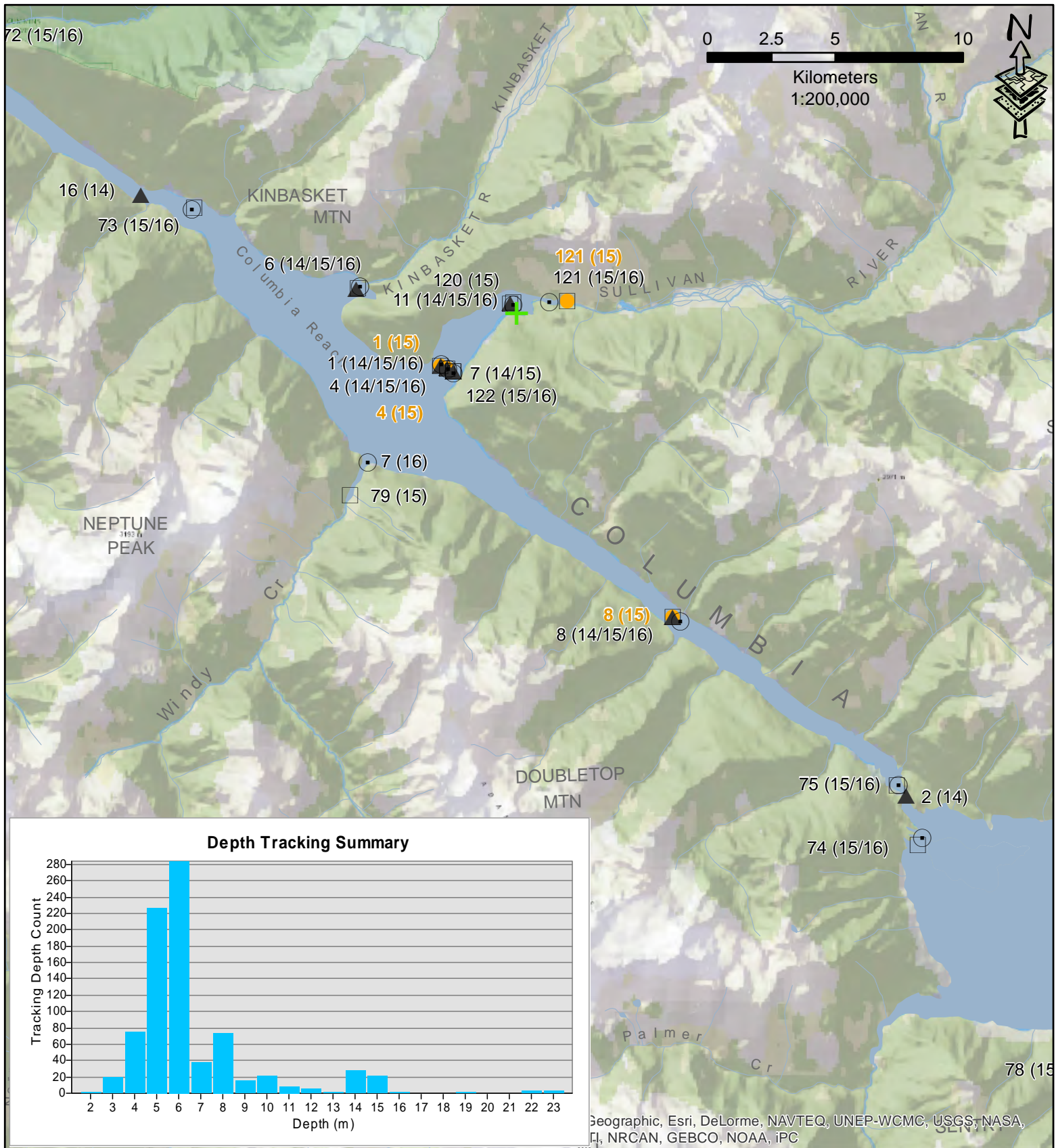


### Kinbasket Reservoir Burbot Tracking Acoustic Code: 36000

- Receiver - Tracking Location (Year)
- ▲ 2014
- ⊕ Capture Location
- 2015
- ⊙ 2016

Receiver ID	6
Tracking Count	2679
Tracking Date Range	12/05/2015 to 23/07/2015
Depth Range	0m - 23m
Average Depth	9.m



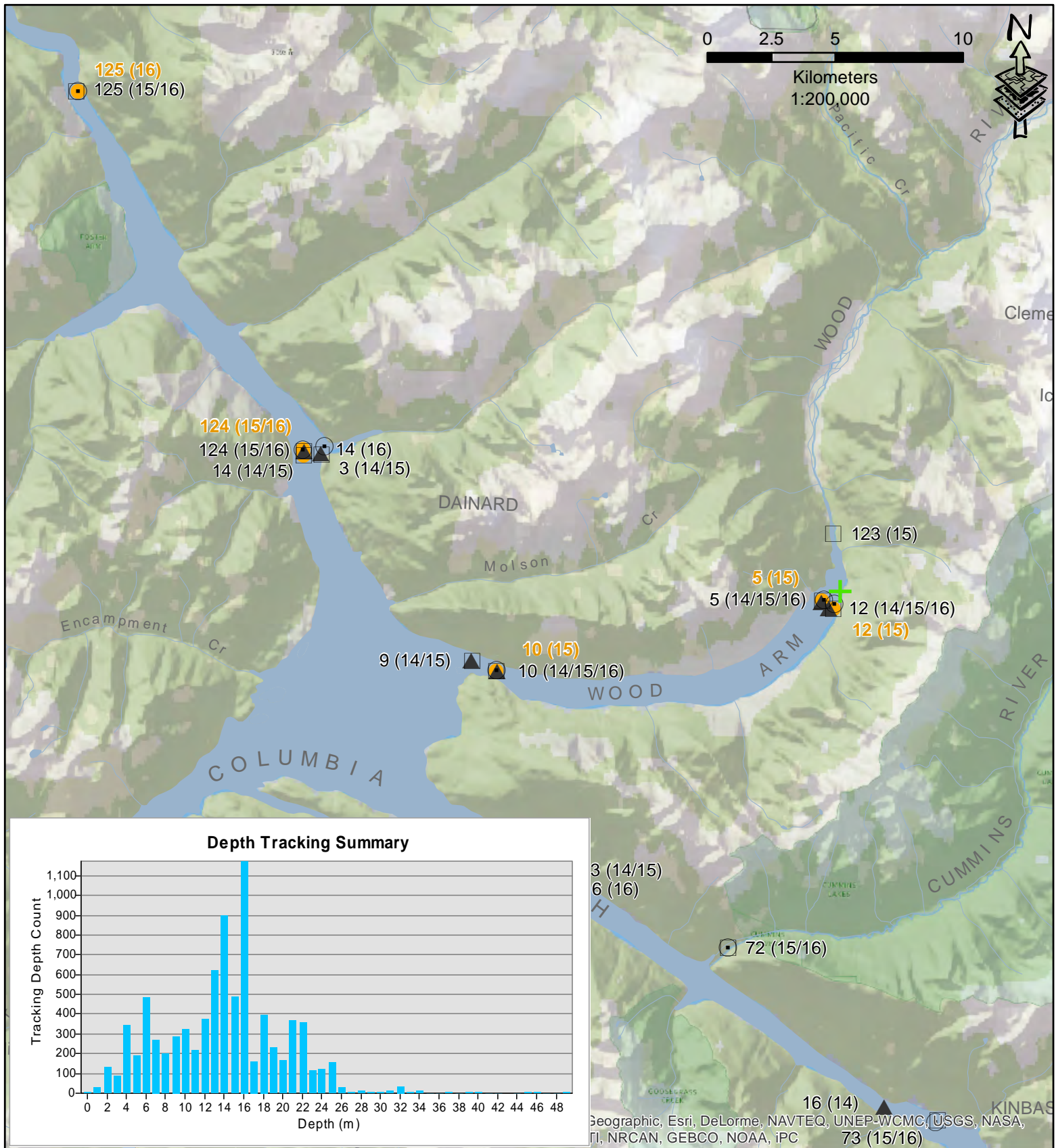


### Kinbasket Reservoir Burbot Tracking Acoustic Code: 36100

- Receiver - Tracking Location (Year)
- ▲ 2014
- ⊕ Capture Location
- 2015
- ⊙ 2016

Receiver ID	1	4	8	121
Tracking Count	36	54	7	731
Tracking Date Range	15/05/2015 to 14/06/2015	15/05/2015 to 14/06/2015	02/06/2015 to 07/06/2015	22/07/2015 to 10/08/2015
Depth Range	2m - 23m	2m - 23m	4m - 10m	3m - 10m
Average Depth	14.9m	12.1m	7.1m	5.8m



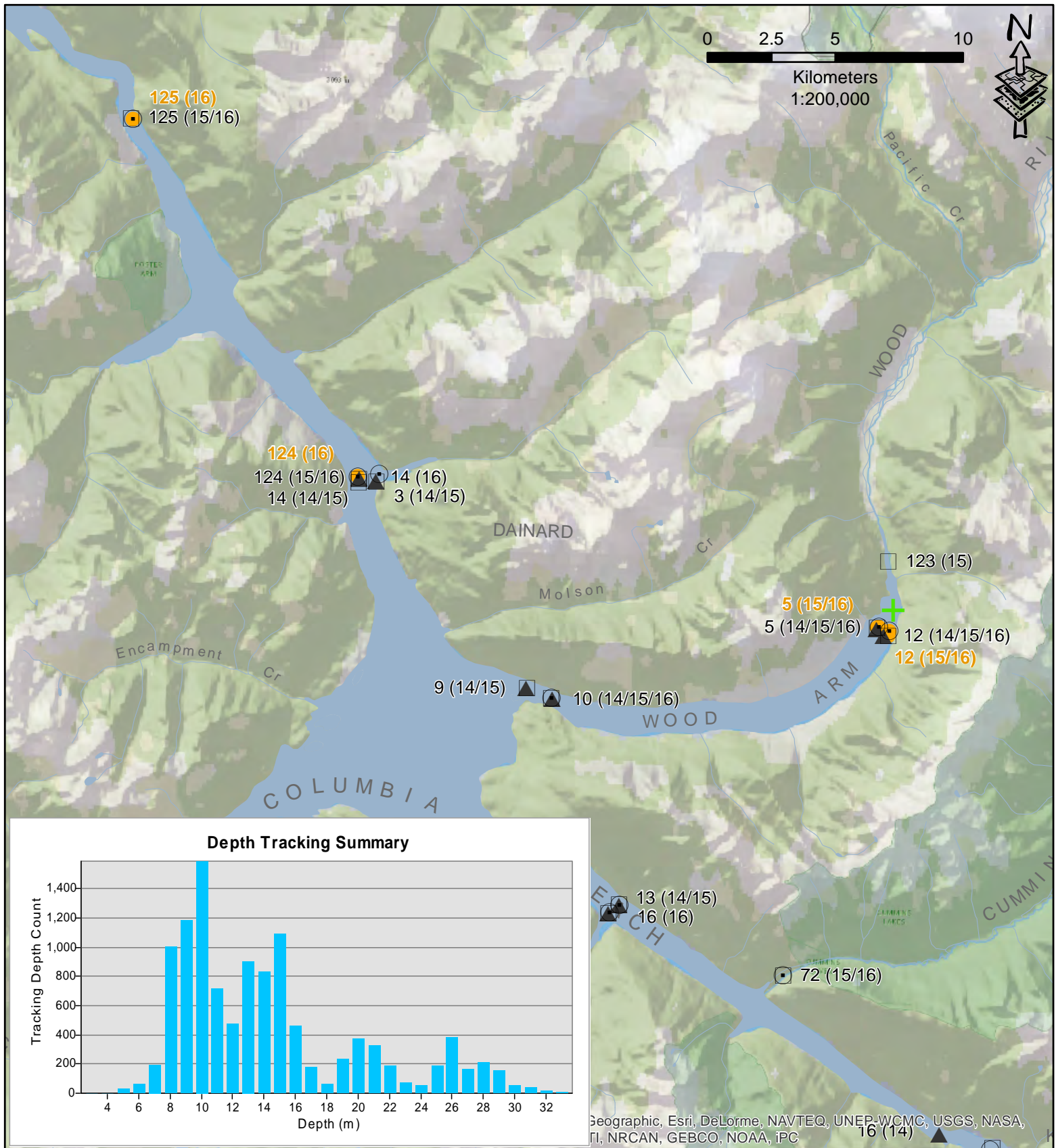


- Receiver - Tracking Location (Year)
- ⊕ Capture Location
- Receiver Location (Year)
- ▲ 2014
- 2015
- 2016

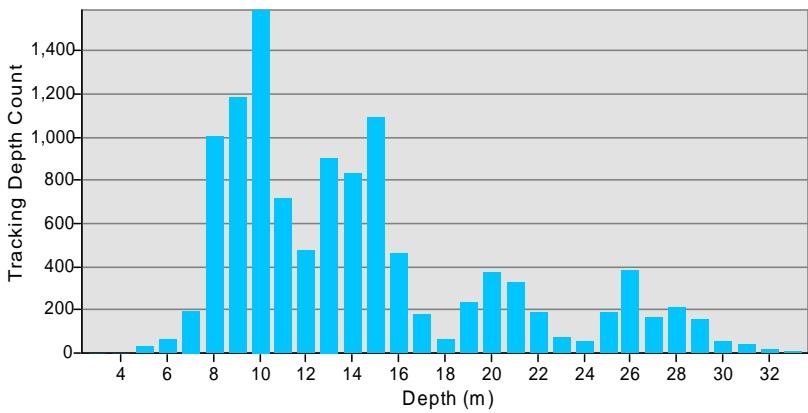
### Kinbasket Reservoir Burbot Tracking Acoustic Code: 36200

Receiver ID	5	10	12	124	125
<b>Tracking Count</b>	2703	607	3426	1519	105
<b>Tracking Date Range</b>	18/05/2015 to 04/11/2015	14/08/2015 to 08/12/2015	17/05/2015 to 04/11/2015	10/12/2015 to 28/04/2016	22/02/2016 to 08/04/2016
<b>Depth Range</b>	0m - 32m	3m - 29m	0m - 32m	4m - 49m	11m - 49m
<b>Average Depth</b>	13.4m	18.9m	13.2m	13.8m	23.8m





**Depth Tracking Summary**

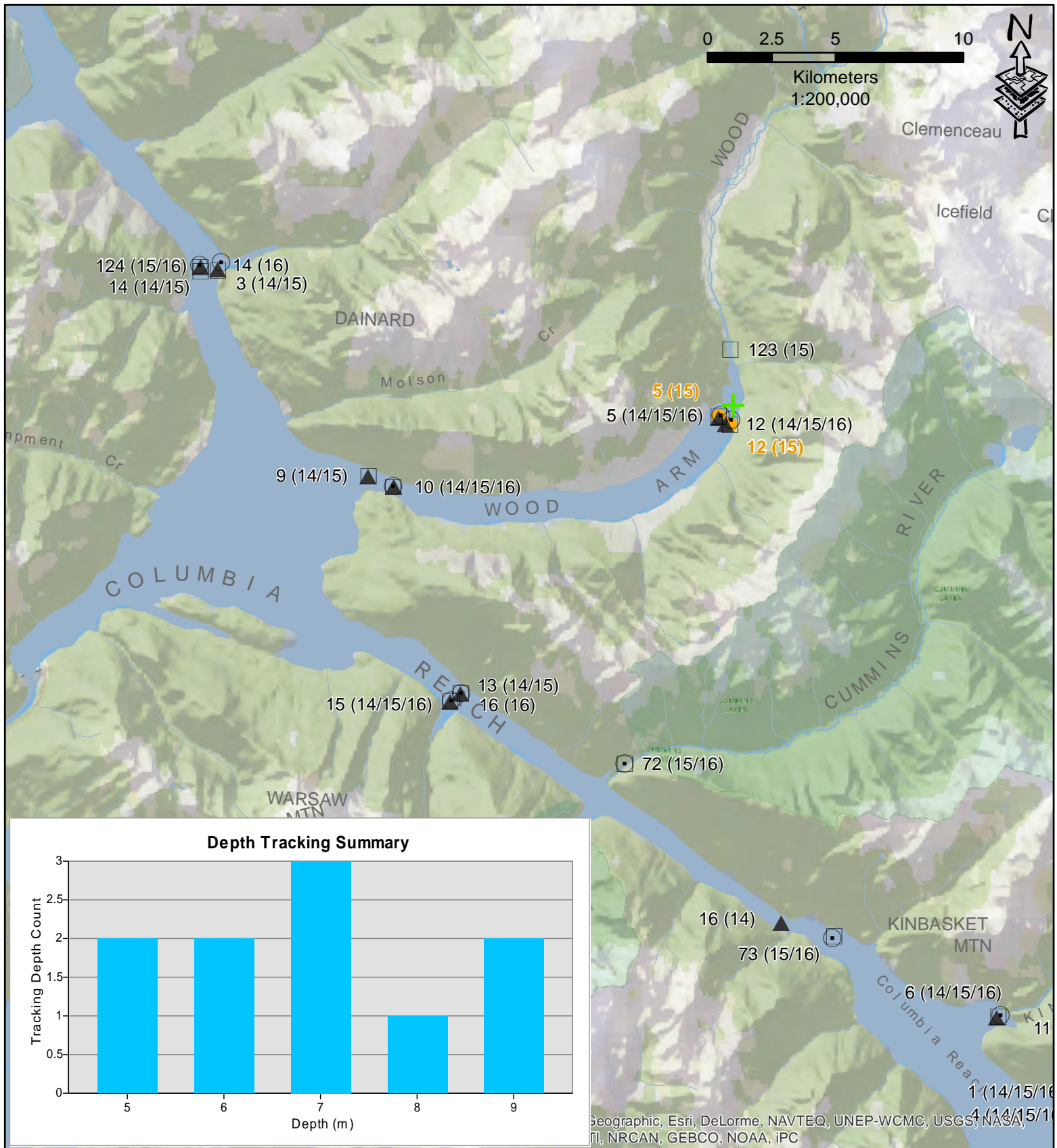


Geographic, Esri, DeLorme, NAVTEQ, UNEP-WCMC, USGS, NASA, FI, NRCAN, GEBCO, NOAA, IPC

- Receiver - Tracking Location (Year)
- + Capture Location
- Receiver Location (Year)
- ▲ 2014
- 2015
- 2016

**Kinbasket Reservoir Burbot Tracking**  
Acoustic Code: 36300

Receiver ID	5	12	124	125
Tracking Count	5497	5709	42	26
Tracking Date Range	21/05/2015 to 29/03/2016	17/05/2015 to 20/03/2016	02/04/2016 to 26/04/2016	11/04/2016 to 24/04/2016
Depth Range	4m - 32m	3m - 33m	15m - 33m	24m - 33m
Average Depth	12.7m	15.6m	21.m	29.4m

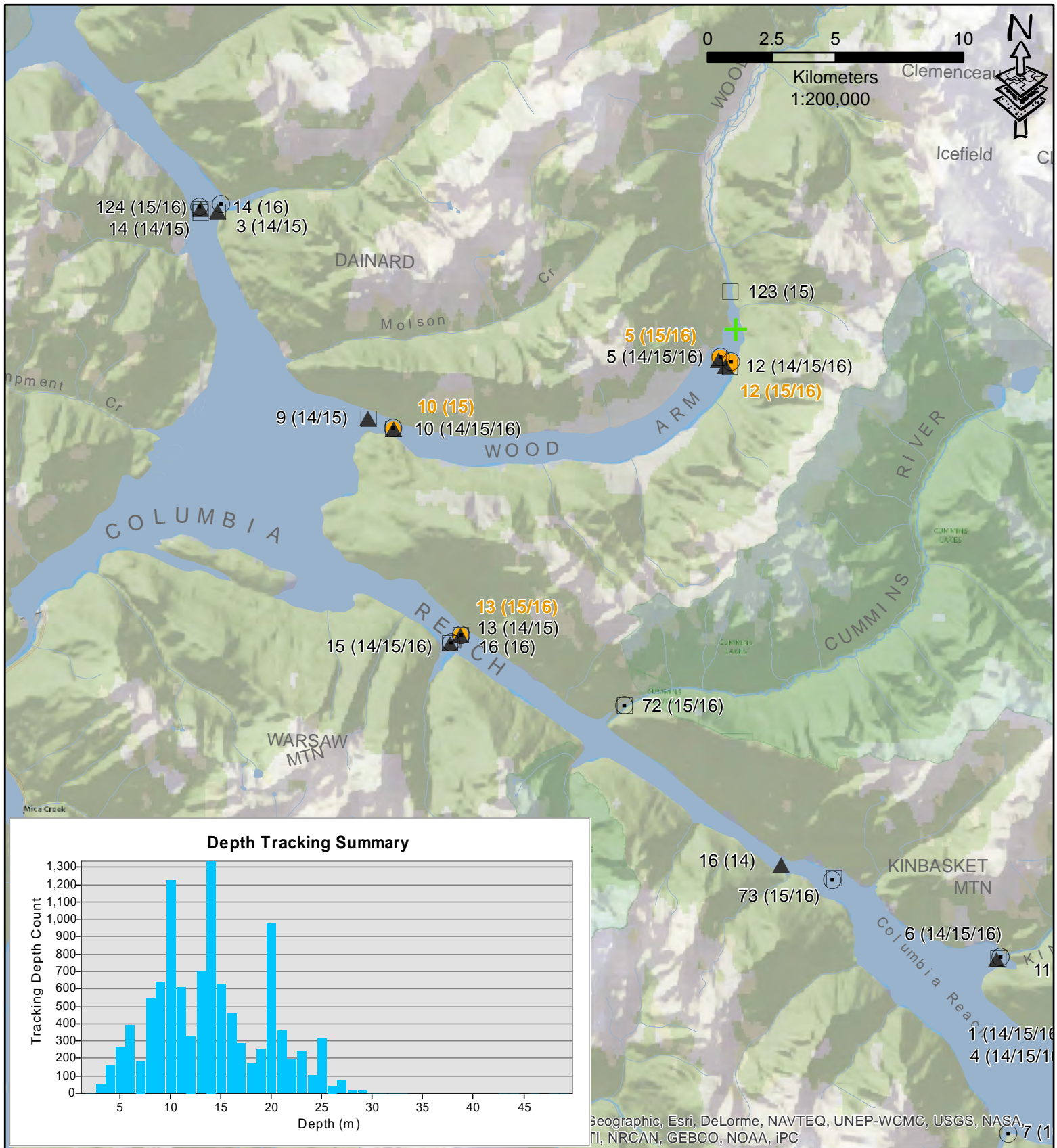


### Kinbasket Reservoir Burbot Tracking Acoustic Code: 36400

- Receiver - Tracking Location (Year)
- ▲ 2014
- ⊕ Capture Location
- 2015
- ⊙ 2016

Receiver ID	5	12
Tracking Count	1	9
Tracking Date Range	13/06/2015 to 13/06/2015	15/05/2015 to 13/06/2015
Depth Range	6m - 6m	5m - 9m
Average Depth	6.m	7.m

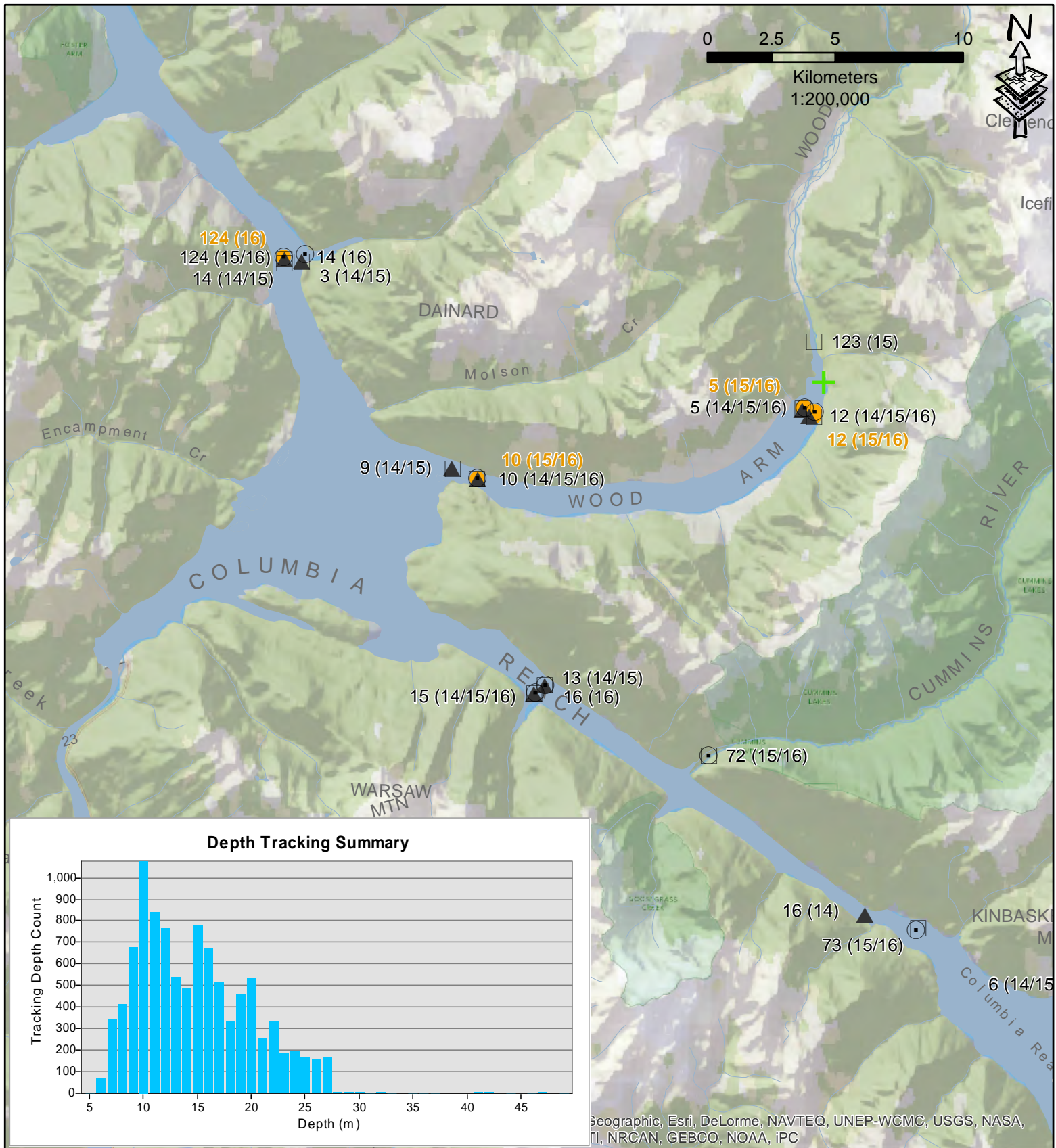




### Kinbasket Reservoir Burbot Tracking Acoustic Code: 36500

- Receiver - Tracking Location (Year)
- ✚ Capture Location
- Receiver Location (Year)
- ▲ 2014
- 2015
- 2016

Receiver ID	5	10	12	13
<b>Tracking Count</b>	5090	20	5447	39
<b>Tracking Date Range</b>	14/05/2015 to 26/04/2016	24/12/2015 to 25/12/2015	13/05/2015 to 11/03/2016	29/12/2015 to 25/01/2016
<b>Depth Range</b>	3m - 31m	15m - 49m	2m - 33m	17m - 24m
<b>Average Depth</b>	13.7m	31.2m	14.1m	21.4m



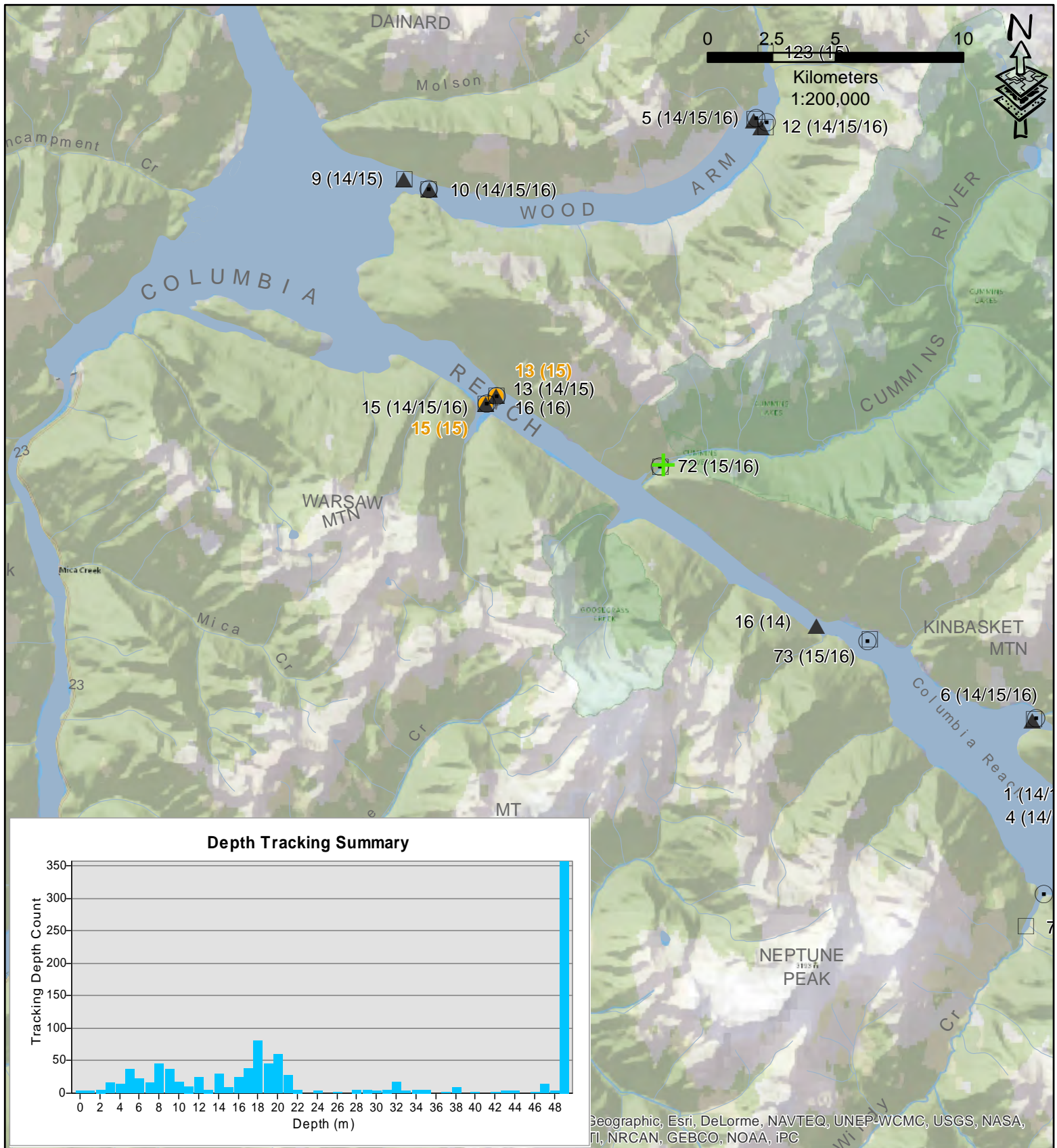
Geographic, Esri, DeLorme, NAVTEQ, UNEP-WCMC, USGS, NASA, FI, NRCAN, GEBCO, NOAA, IPC

- Receiver - Tracking Location (Year)
- ✚ Capture Location
- Receiver Location (Year)
- ▲ 2014
- 2015
- 2016

### Kinbasket Reservoir Burbot Tracking Acoustic Code: 36600

Receiver ID	5	10	12	124
<b>Tracking Count</b>	4245	866	4881	5
<b>Tracking Date Range</b>	03/09/2015 to 24/04/2016	04/12/2015 to 15/02/2016	01/09/2015 to 26/02/2016	10/04/2016 to 14/04/2016
<b>Depth Range</b>	6m - 27m	12m - 47m	5m - 27m	28m - 49m
<b>Average Depth</b>	13.9m	21.1m	14.3m	35.m



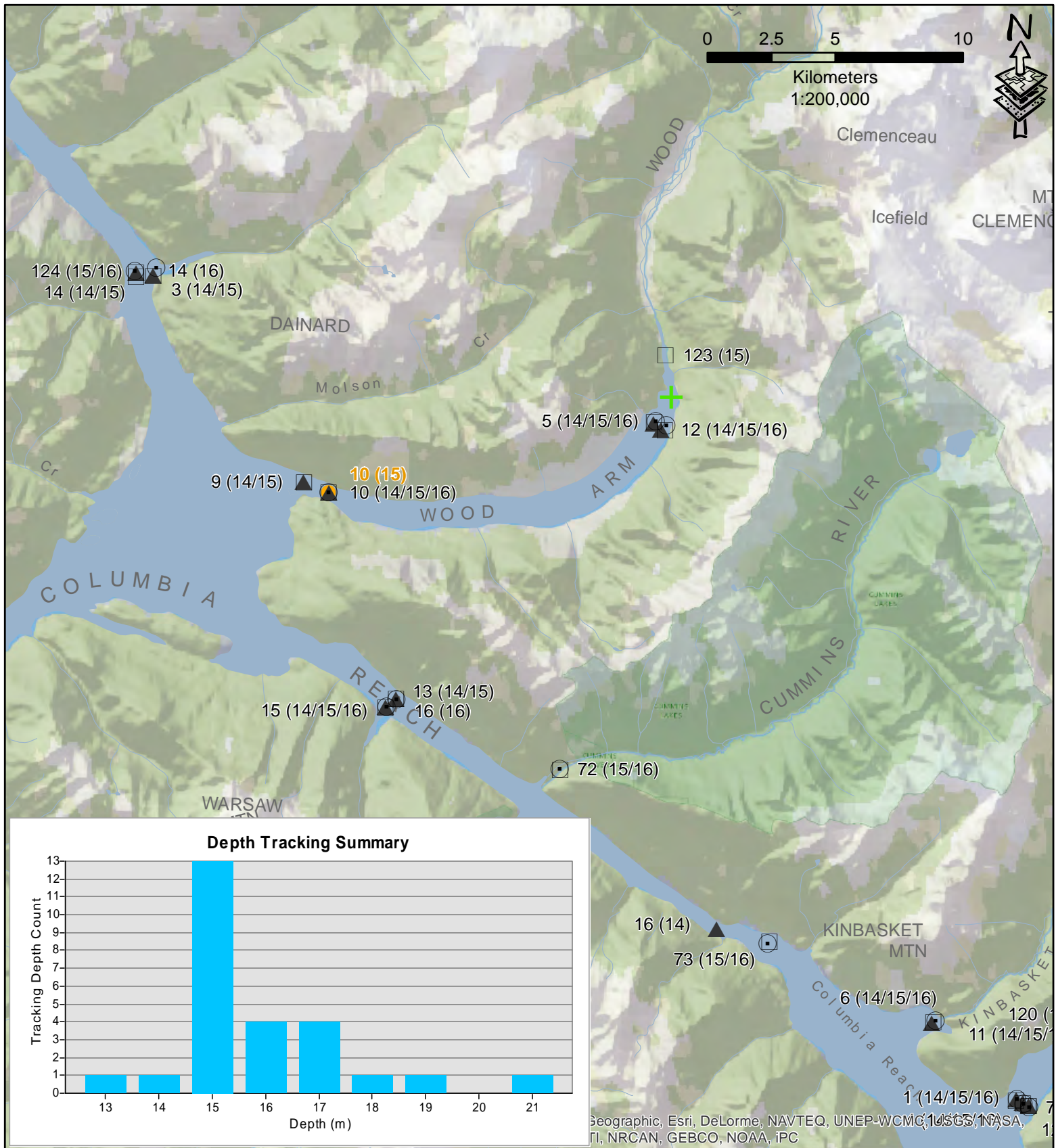


### Kinbasket Reservoir Burbot Tracking Acoustic Code: 36700

Note: Missing location receiver 113

- Receiver - Tracking Location (Year)
- + Capture Location
- ▲ 2014
- 2015
- ⊙ 2016

Receiver ID	113	13	15
Tracking Count	13	592	415
Tracking Date Range	03/08/2015 to 03/08/2015	15/05/2015 to 18/07/2015	15/05/2015 to 18/07/2015
Depth Range	5m - 12m	3m - 49m	0m - 49m
Average Depth	9.8m	33.7m	20.1m

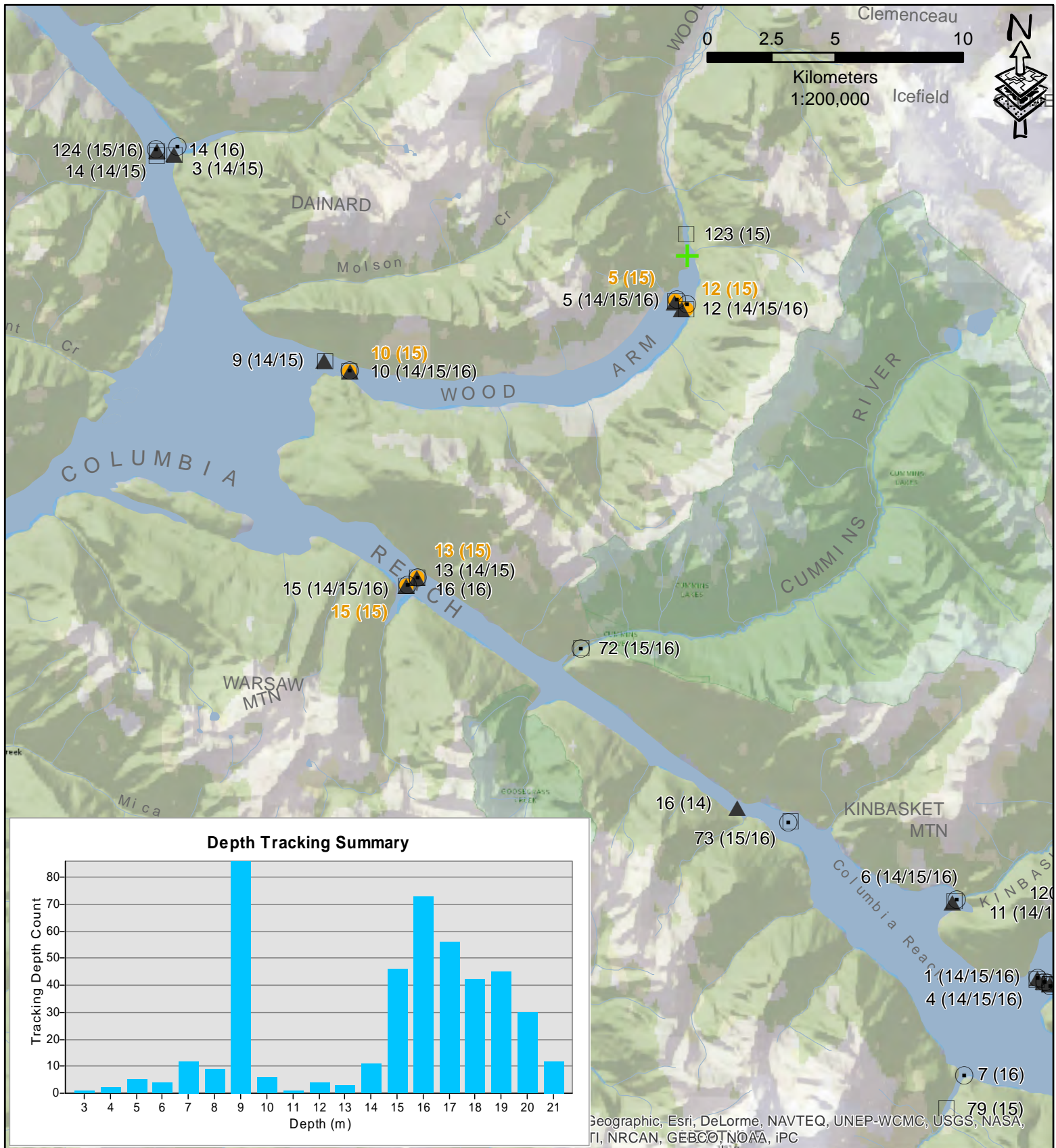


### Kinbasket Reservoir Burbot Tracking Acoustic Code: 36800

- Receiver - Tracking Location (Year)
- ▲ 2014
- ✚ Capture Location
- 2015
- ⦿ 2016

<b>Receiver ID</b>	10
<b>Tracking Count</b>	26
<b>Tracking Date Range</b>	13/05/2015 to 13/05/2015
<b>Depth Range</b>	13m - 21m
<b>Average Depth</b>	15.8m



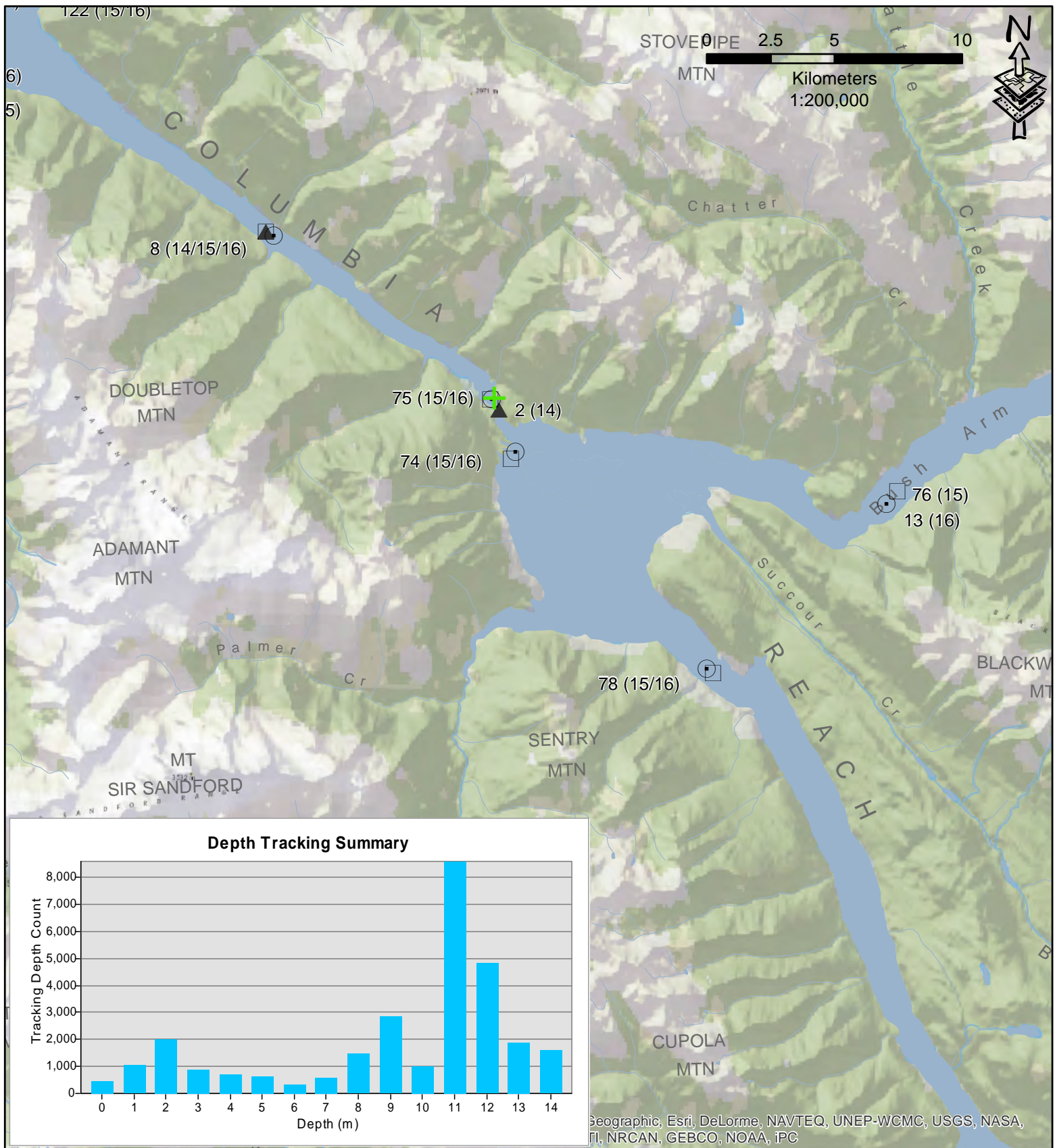


- Receiver - Tracking Location (Year)
- + Capture Location
- Receiver Location (Year)
- ▲ 2014
- 2015
- 2016

### Kinbasket Reservoir Burbot Tracking Acoustic Code: 36900

Receiver ID	5	10	12	13	15
<b>Tracking Count</b>	149	23	240	20	16
<b>Tracking Date Range</b>	24/05/2015 to 16/07/2015	22/06/2015 to 21/07/2015	24/05/2015 to 16/07/2015	24/06/2015 to 07/07/2015	24/06/2015 to 07/07/2015
<b>Depth Range</b>	4m - 21m	8m - 18m	3m - 21m	9m - 17m	14m - 18m
<b>Average Depth</b>	16.m	15.3m	13.7m	15.3m	16.3m





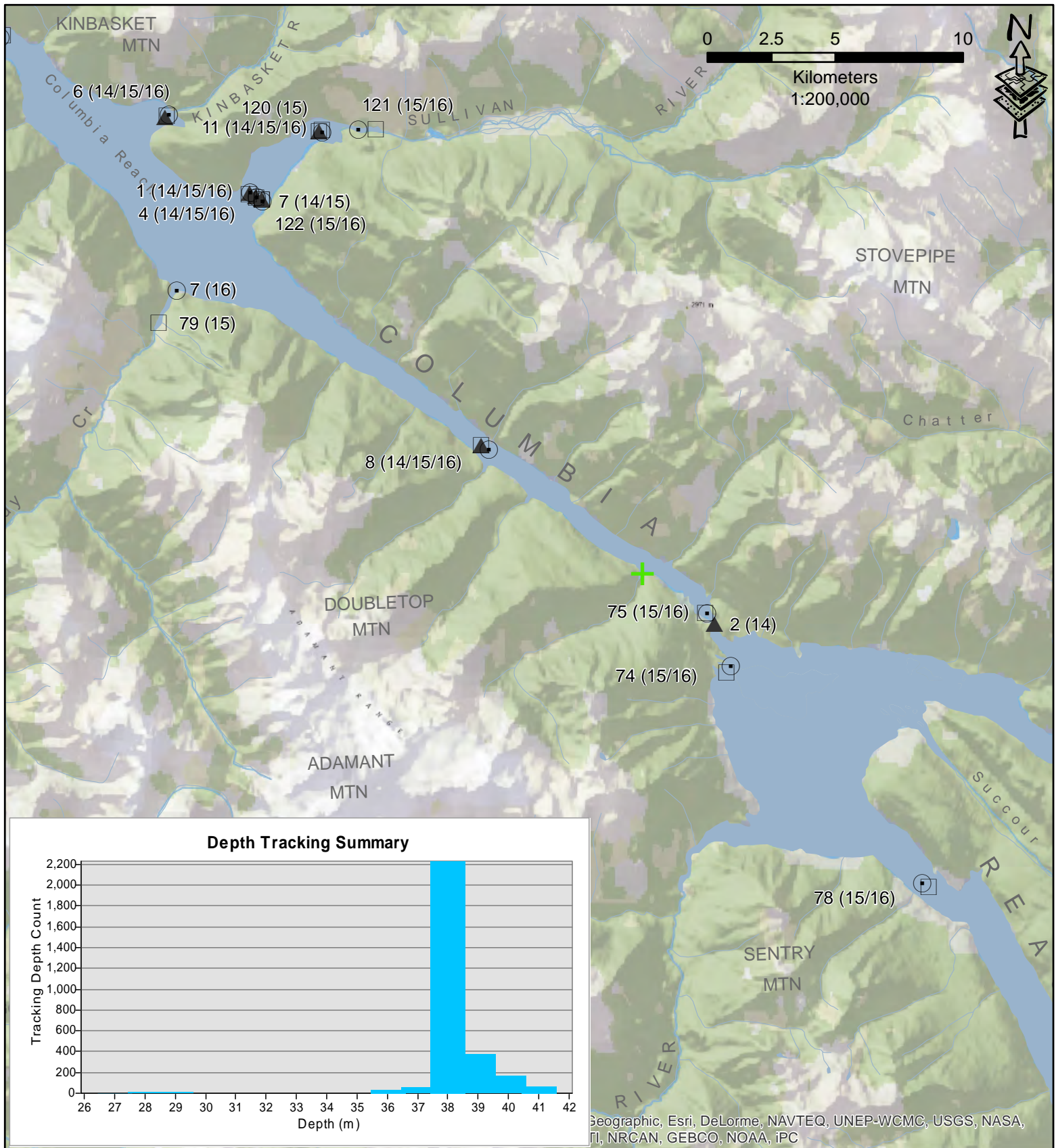
### Kinbasket Reservoir Burbot Tracking Acoustic Code: 37000

- + Capture Location
- Receiver Location (Year)
  - ▲ 2014
  - 2015
  - ⊙ 2016

Note: Missing location receiver 115

<b>Receiver ID</b>	115
<b>Tracking Count</b>	28904
<b>Tracking Date Range</b>	25/07/2015 to 06/05/2016
<b>Depth Range</b>	0m - 14m
<b>Average Depth</b>	9.2m





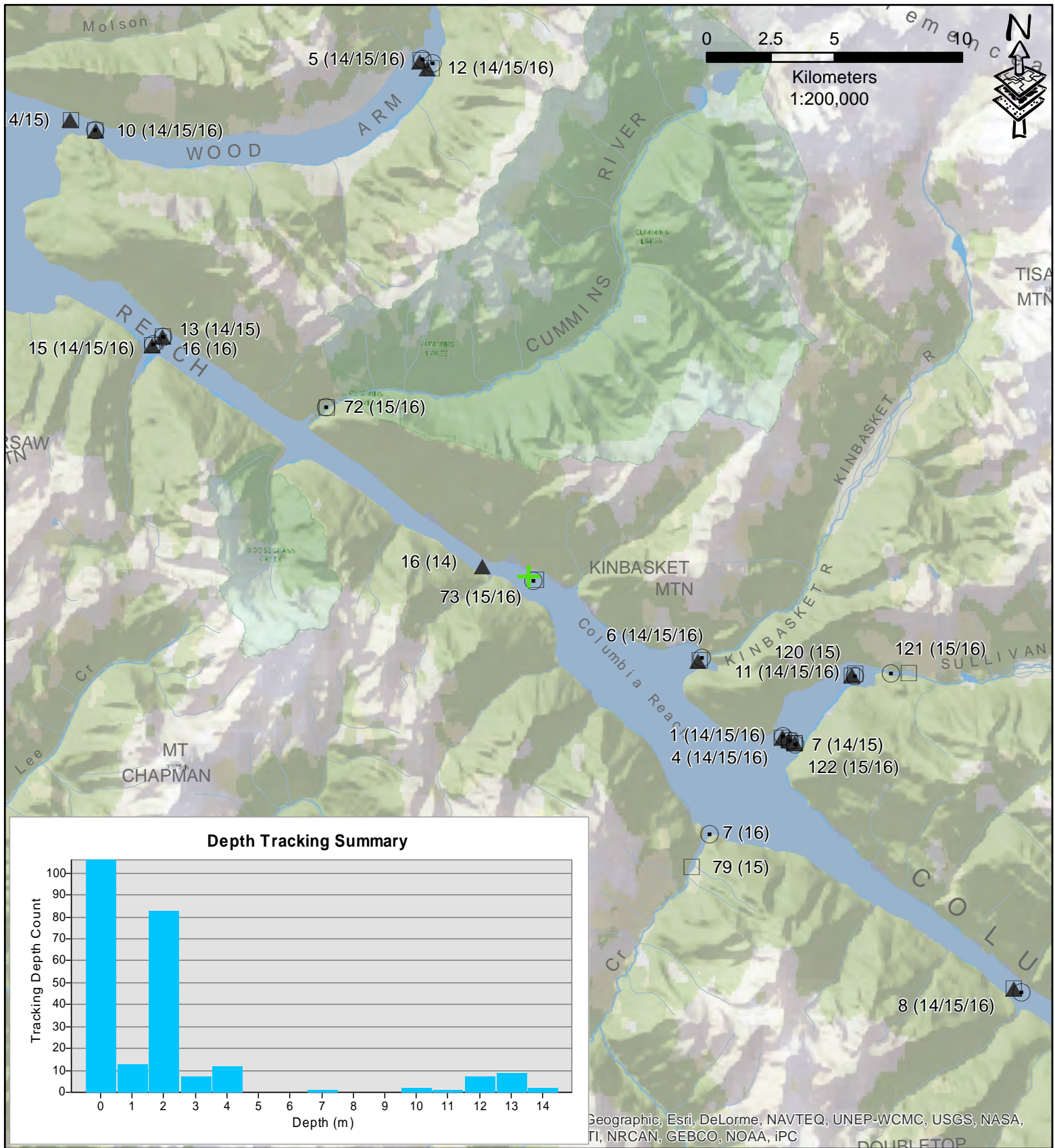
**Kinbasket Reservoir Burbot Tracking**  
**Acoustic Code: 37200**

- + Capture Location
- ▲ Receiver Location (Year) 2014
- Receiver Location (Year) 2015
- Receiver Location (Year) 2016

Note: Missing location receiver 115

<b>Receiver ID</b>	115
<b>Tracking Count</b>	2940
<b>Tracking Date Range</b>	25/07/2015 to 06/05/2016
<b>Depth Range</b>	27m - 41m
<b>Average Depth</b>	38.2m





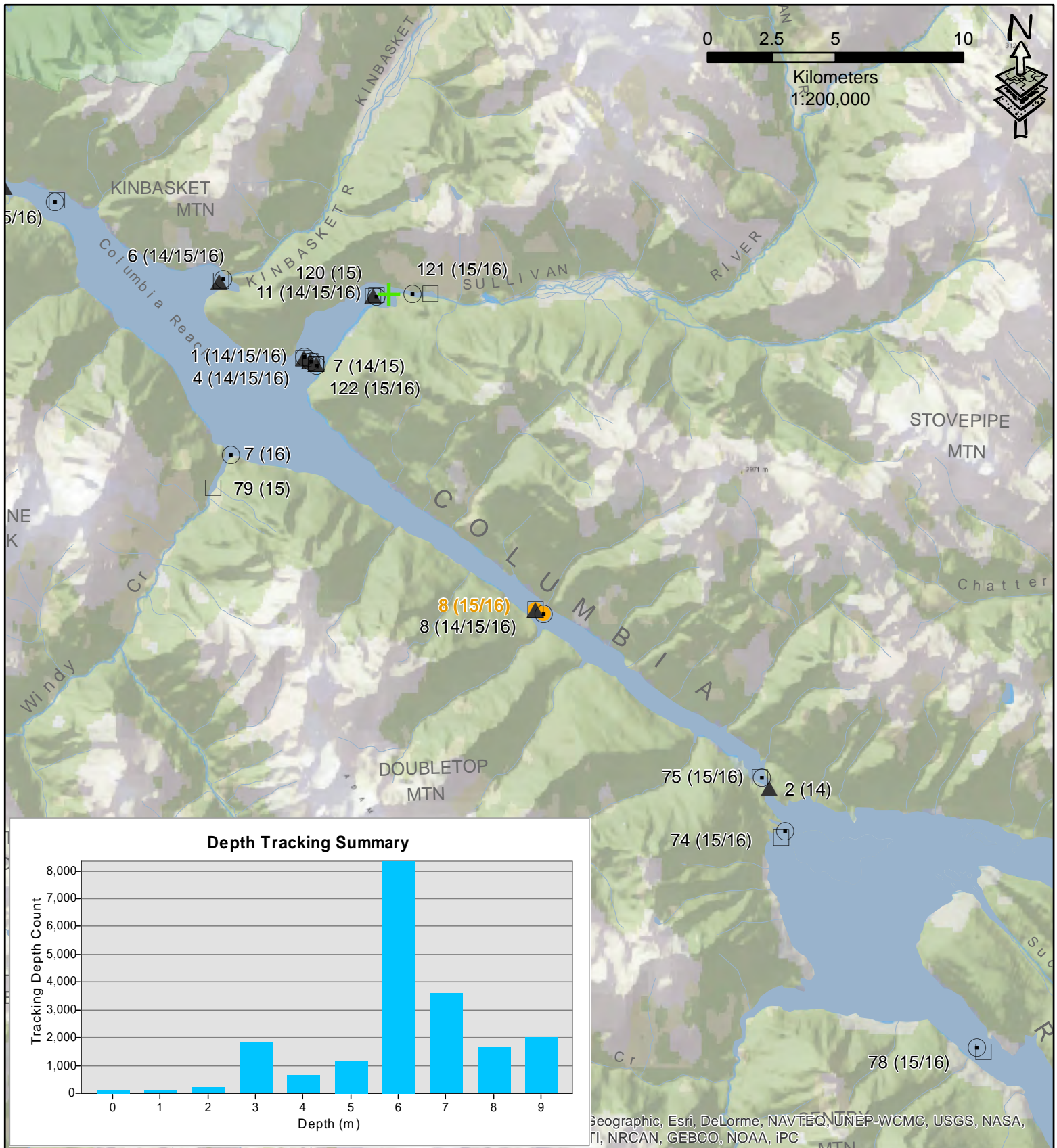
### Kinbasket Reservoir Burbot Tracking Acoustic Code: 37300

- + Capture Location
- Receiver Location (Year)
- 2014
- 2015
- 2016

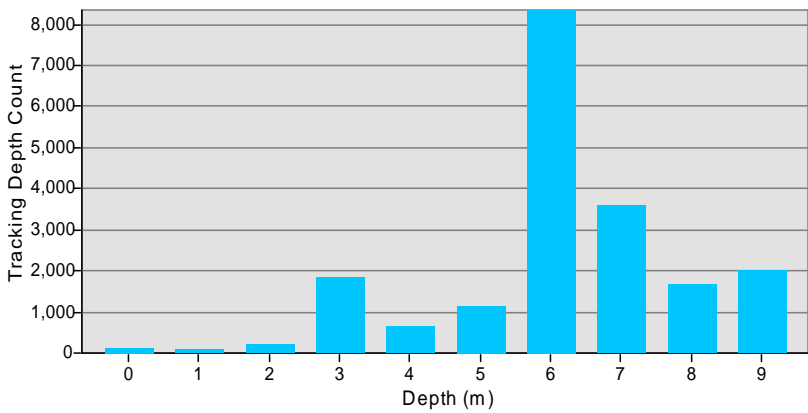
Note: Missing location receiver 113

<b>Receiver ID</b>	113
<b>Tracking Count</b>	243
<b>Tracking Date Range</b>	25/07/2015 to 01/09/2015
<b>Depth Range</b>	0m - 14m
<b>Average Depth</b>	2.1m





**Depth Tracking Summary**



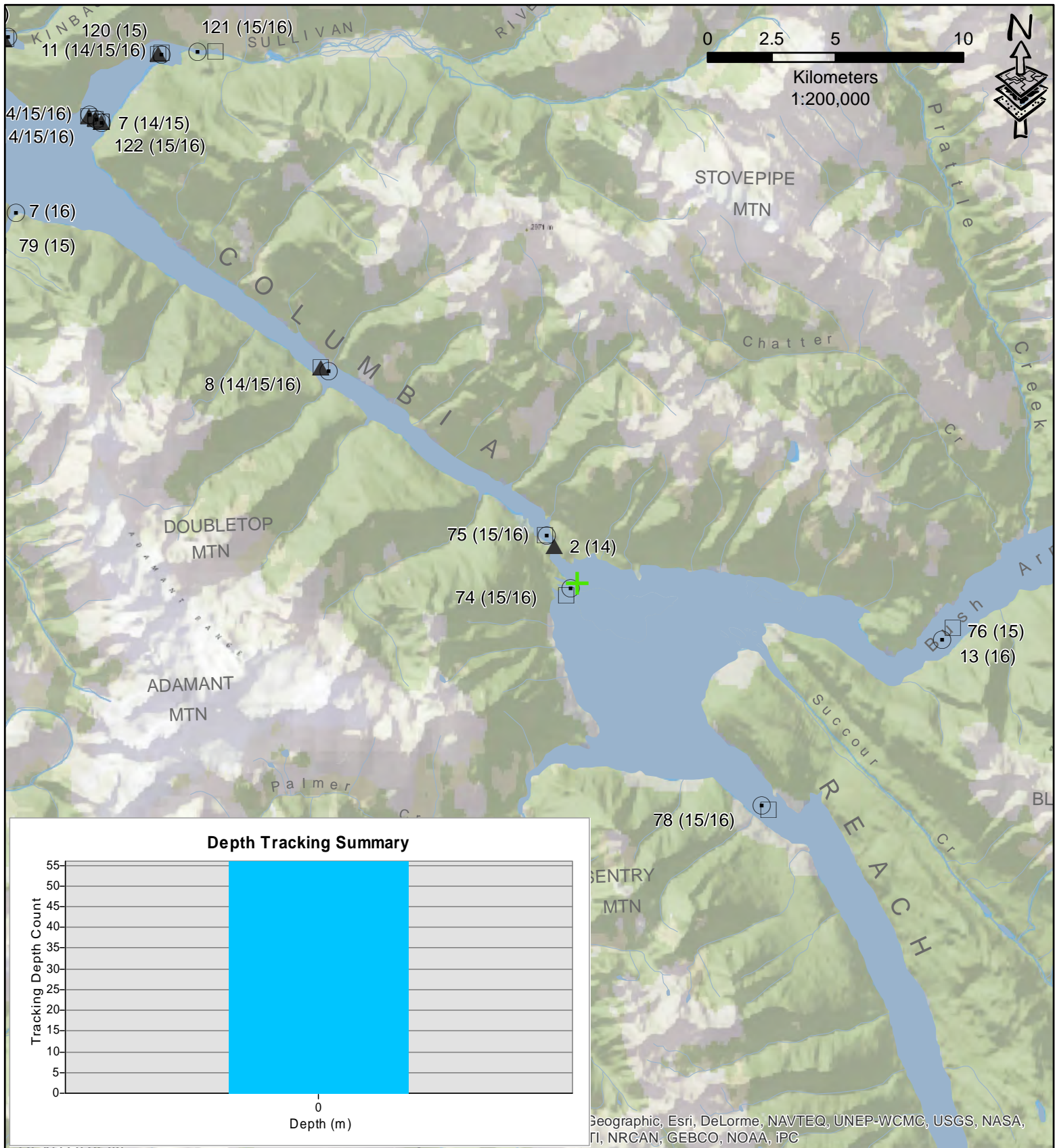
Geographic, Esri, DeLorme, NAVTEQ, UNEP-WCMC, USGS, NASA, FI, NRCAN, GEBCO, NOAA, IPC

**Kinbasket Reservoir Burbot Tracking  
Acoustic Code: 37500**

- Receiver - Tracking Location (Year)
- ▲ 2014
- ⊕ Capture Location
- 2015
- 2016

<b>Receiver ID</b>	8
<b>Tracking Count</b>	19668
<b>Tracking Date Range</b>	18/05/2015 to 10/01/2016
<b>Depth Range</b>	0m - 9m
<b>Average Depth</b>	6.2m





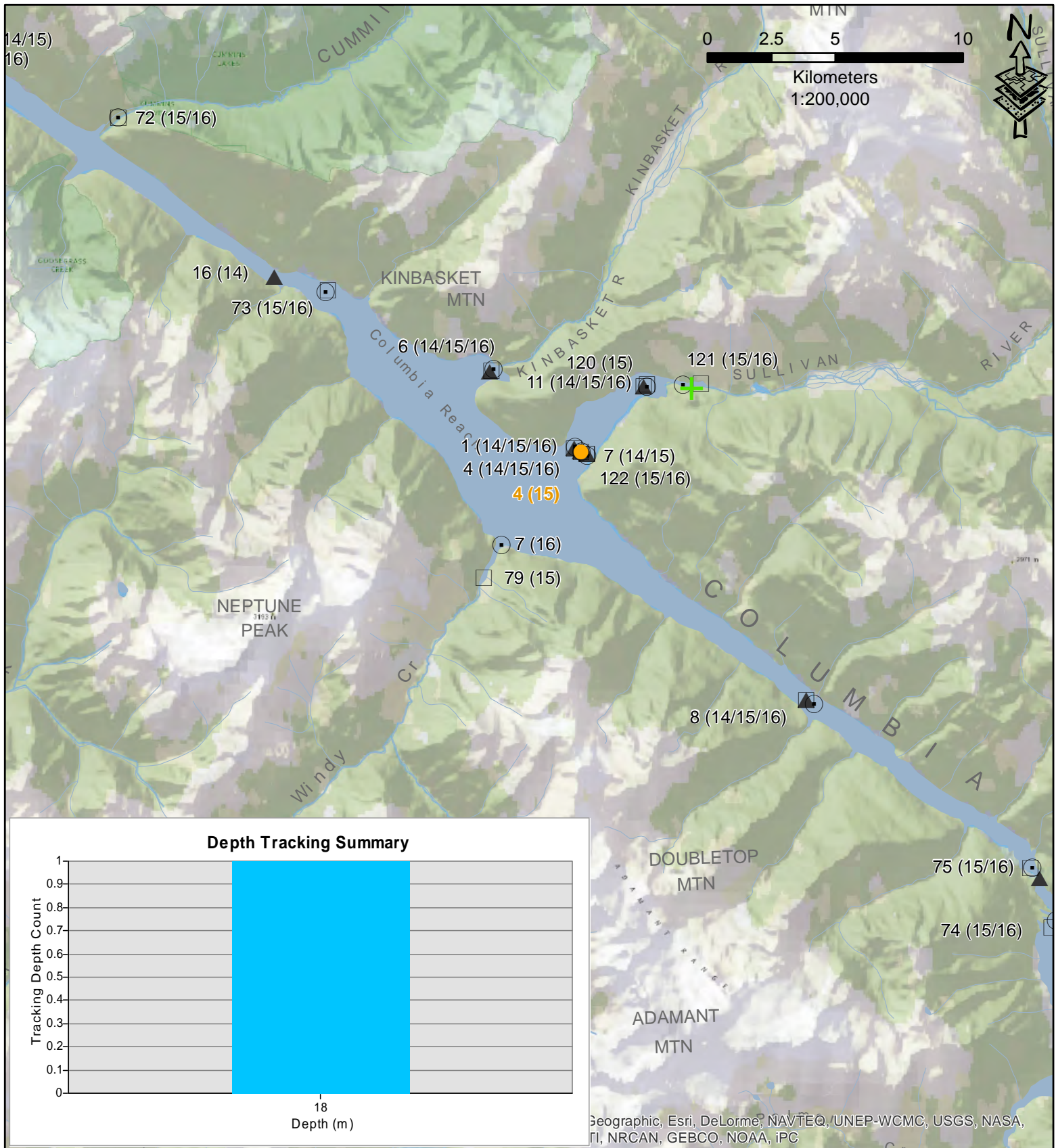
### Kinbasket Reservoir Burbot Tracking Acoustic Code: 37600

- + Capture Location
- Receiver Location (Year)
  - ▲ 2014
  - 2015
  - ⊙ 2016

Note: Missing location receiver 114

<b>Receiver ID</b>	114
<b>Tracking Count</b>	56
<b>Tracking Date Range</b>	25/07/2015 to 30/07/2015
<b>Depth Range</b>	0m - 0m
<b>Average Depth</b>	.m



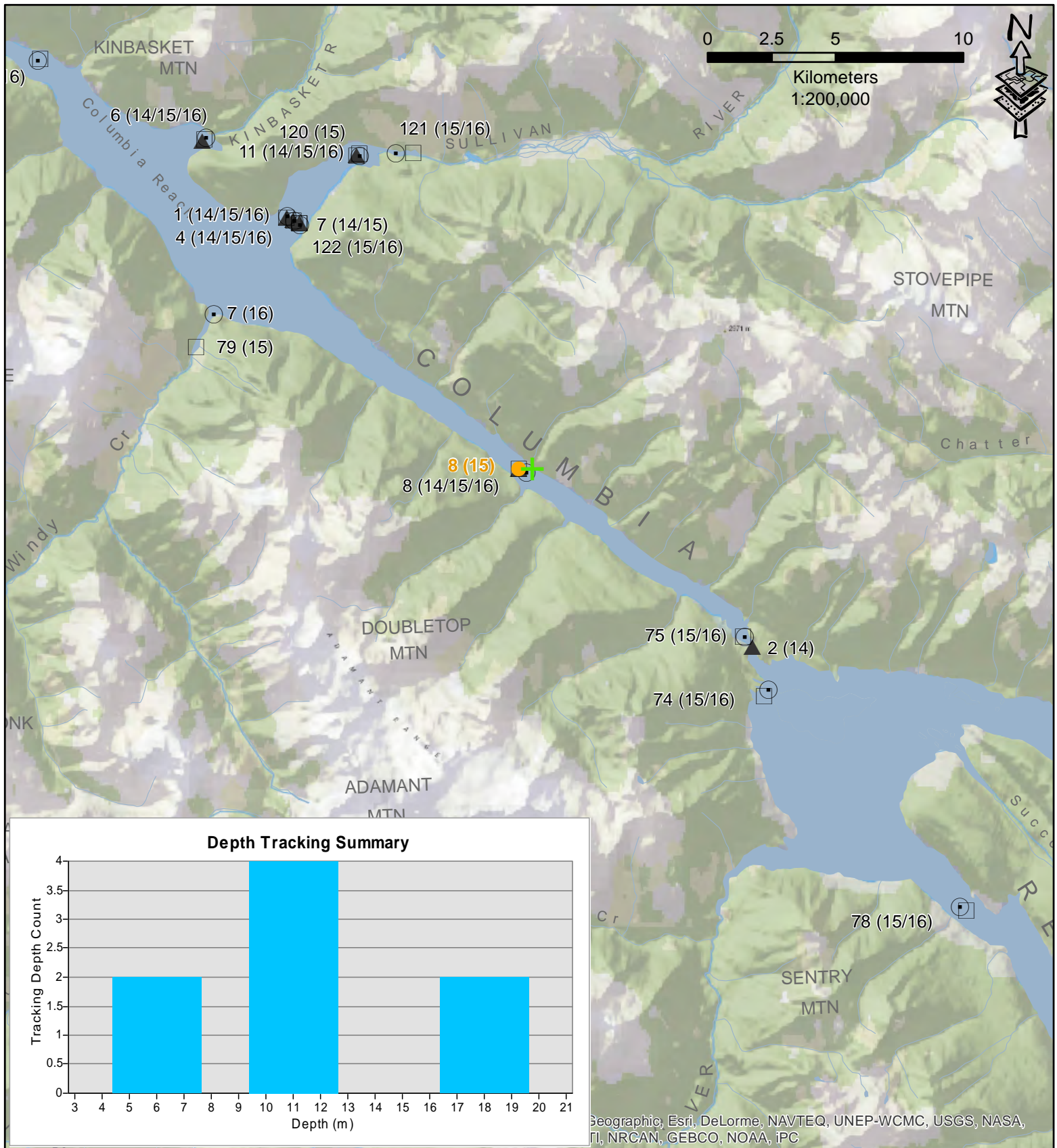


### Kinbasket Reservoir Burbot Tracking Acoustic Code: 37800

- Receiver - Tracking Location (Year)
- ▲ 2014
- + Capture Location
- 2015
- 2016

<b>Receiver ID</b>	4
<b>Tracking Count</b>	1
<b>Tracking Date Range</b>	12/05/2015 to 12/05/2015
<b>Depth Range</b>	18m - 18m
<b>Average Depth</b>	18.m





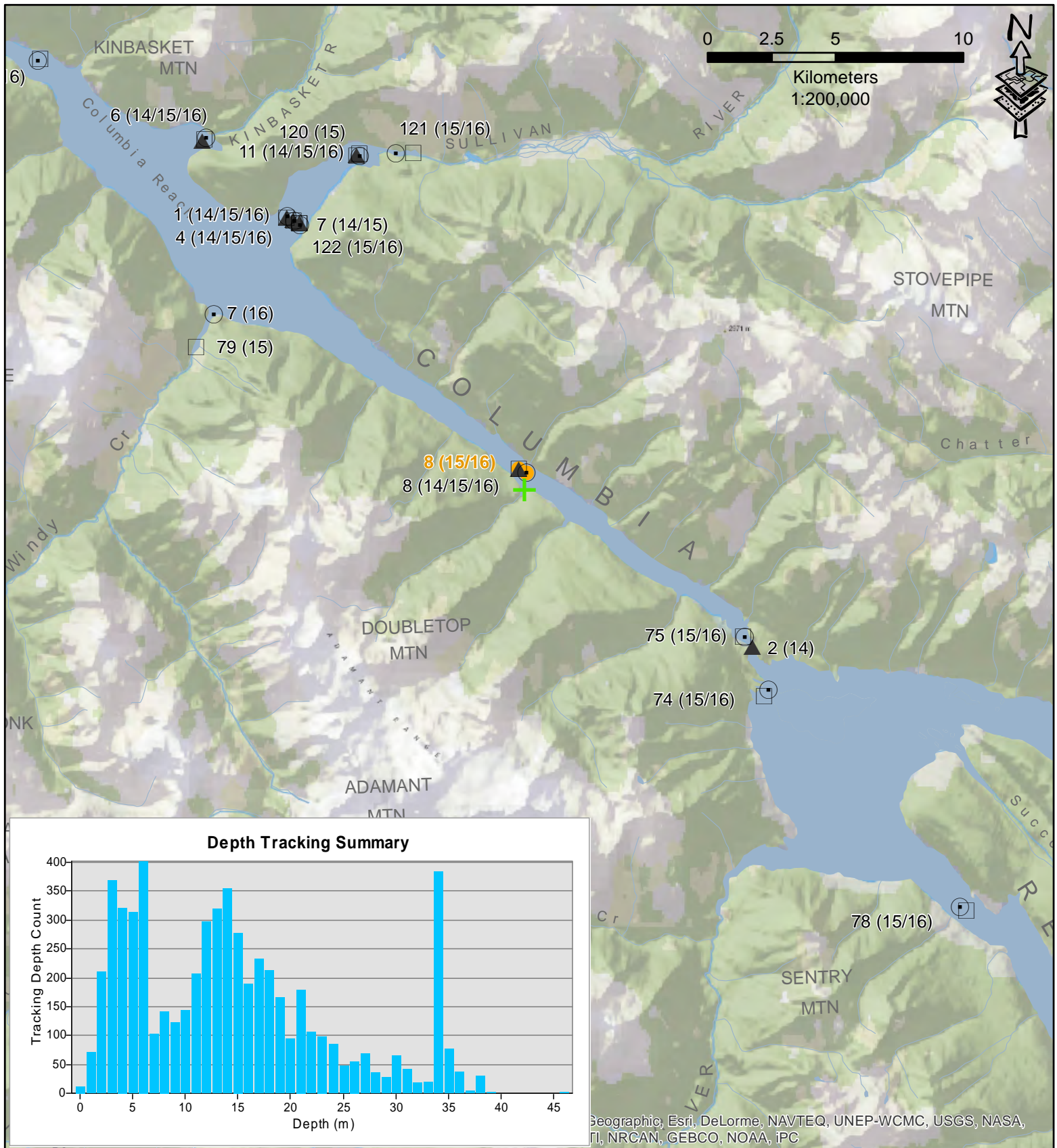
### Kinbasket Reservoir Burbot Tracking Acoustic Code: 37900

- Receiver - Tracking Location (Year)
- ▲ 2014
- + Capture Location
- 2015
- 2016

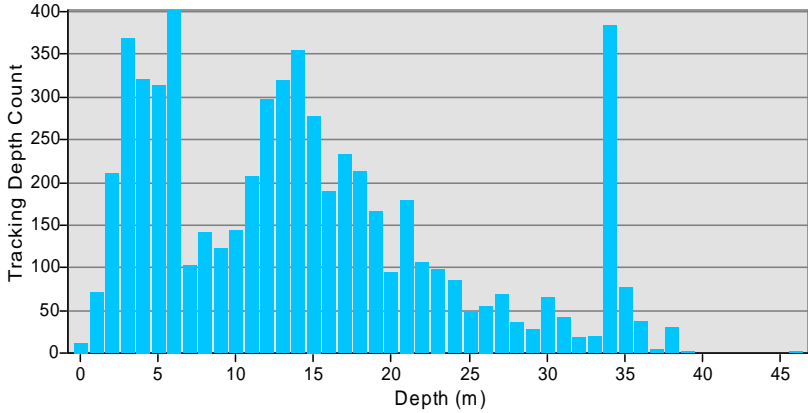
Note: Missing location receiver 115

<b>Receiver ID</b>	8	115
<b>Tracking Count</b>	2	6
<b>Tracking Date Range</b>	18/06/2015 to 18/06/2015	26/07/2015 to 20/08/2015
<b>Depth Range</b>	11m - 18m	6m - 18m
<b>Average Depth</b>	14.5m	10.5m





**Depth Tracking Summary**



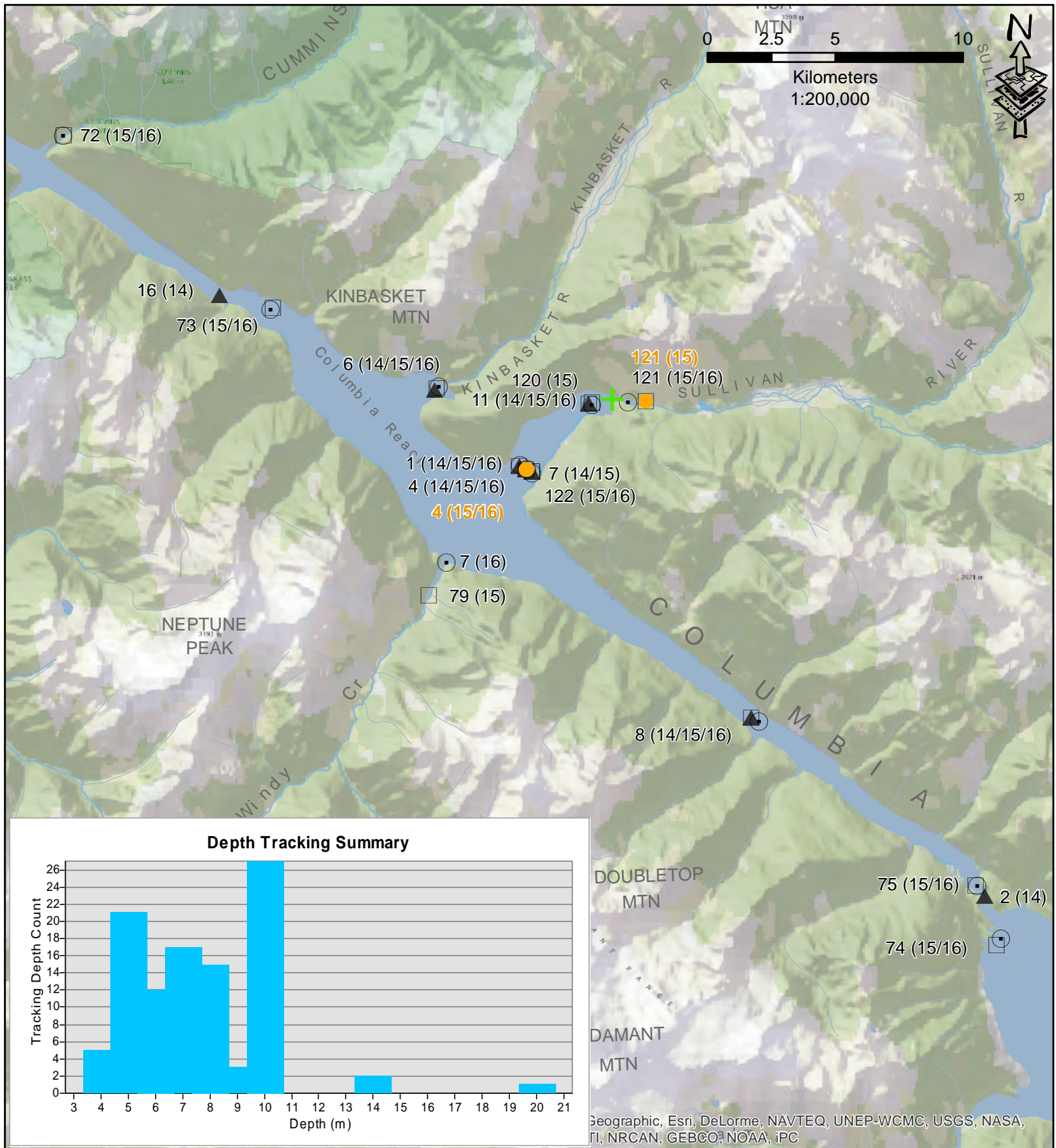
Geographic, Esri, DeLorme, NAVTEQ, UNEP-WCMC, USGS, NASA, FI, NRCAN, GEBCO, NOAA, IPC

**Kinbasket Reservoir Burbot Tracking  
Acoustic Code: 38100**

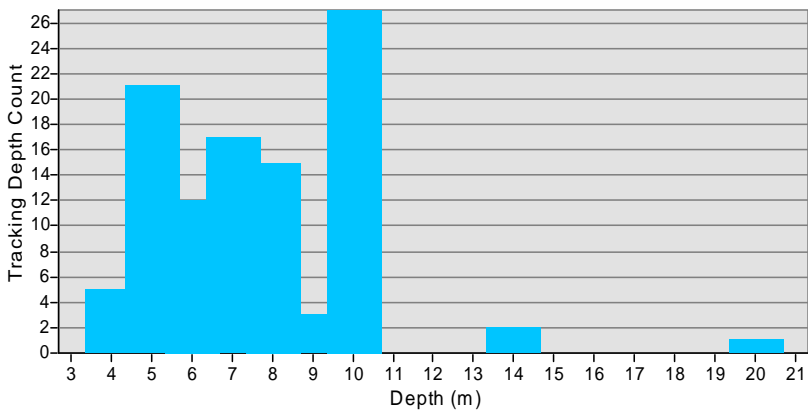
- Receiver - Tracking Location (Year)
- ▲ 2014
- + Capture Location
- 2015
- 2016

<b>Receiver ID</b>	8
<b>Tracking Count</b>	5942
<b>Tracking Date Range</b>	13/05/2015 to 04/05/2016
<b>Depth Range</b>	0m - 46m
<b>Average Depth</b>	14.5m





**Depth Tracking Summary**

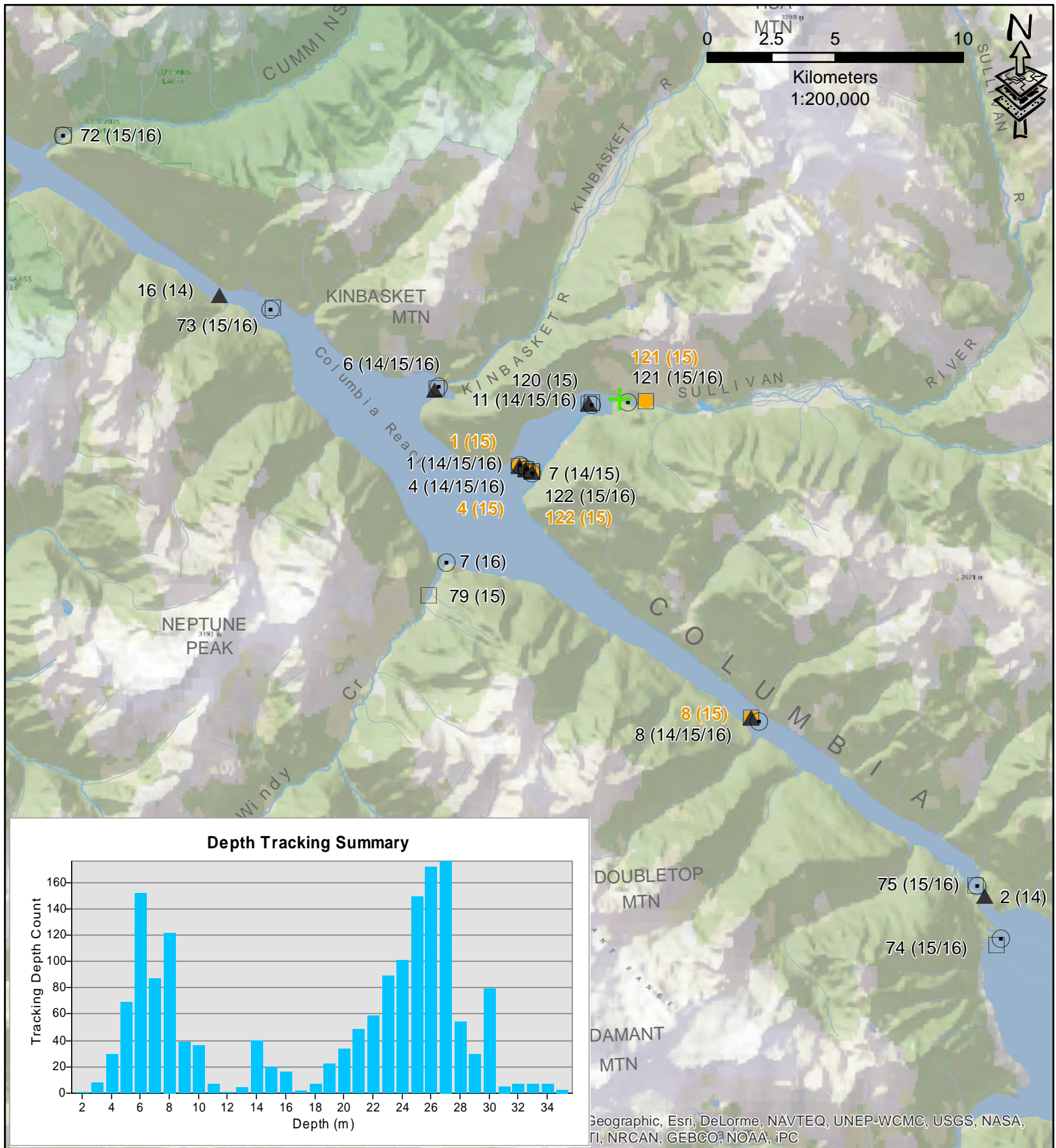


**Kinbasket Reservoir Burbot Tracking  
Acoustic Code: 38200**

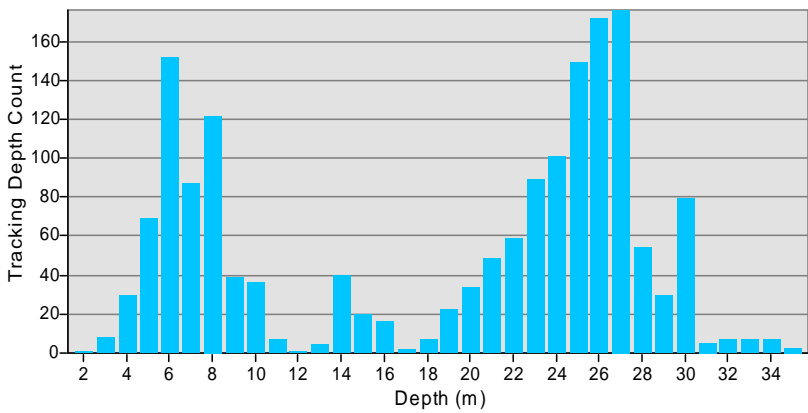
- Receiver - Tracking Location (Year)
- + Capture Location
- ▲ 2014
- 2015
- 2016

<b>Receiver ID</b>	4	121
<b>Tracking Count</b>	3	100
<b>Tracking Date Range</b>	24/11/2015 to 14/01/2016	23/07/2015 to 31/07/2015
<b>Depth Range</b>	14m - 20m	4m - 10m
<b>Average Depth</b>	16.m	7.3m





**Depth Tracking Summary**



Geographic, Esri, DeLorme, NAVTEQ, UNEP-WCMC, USGS, NASA, FI, NRCAN, GEBCO, NOAA, IPC

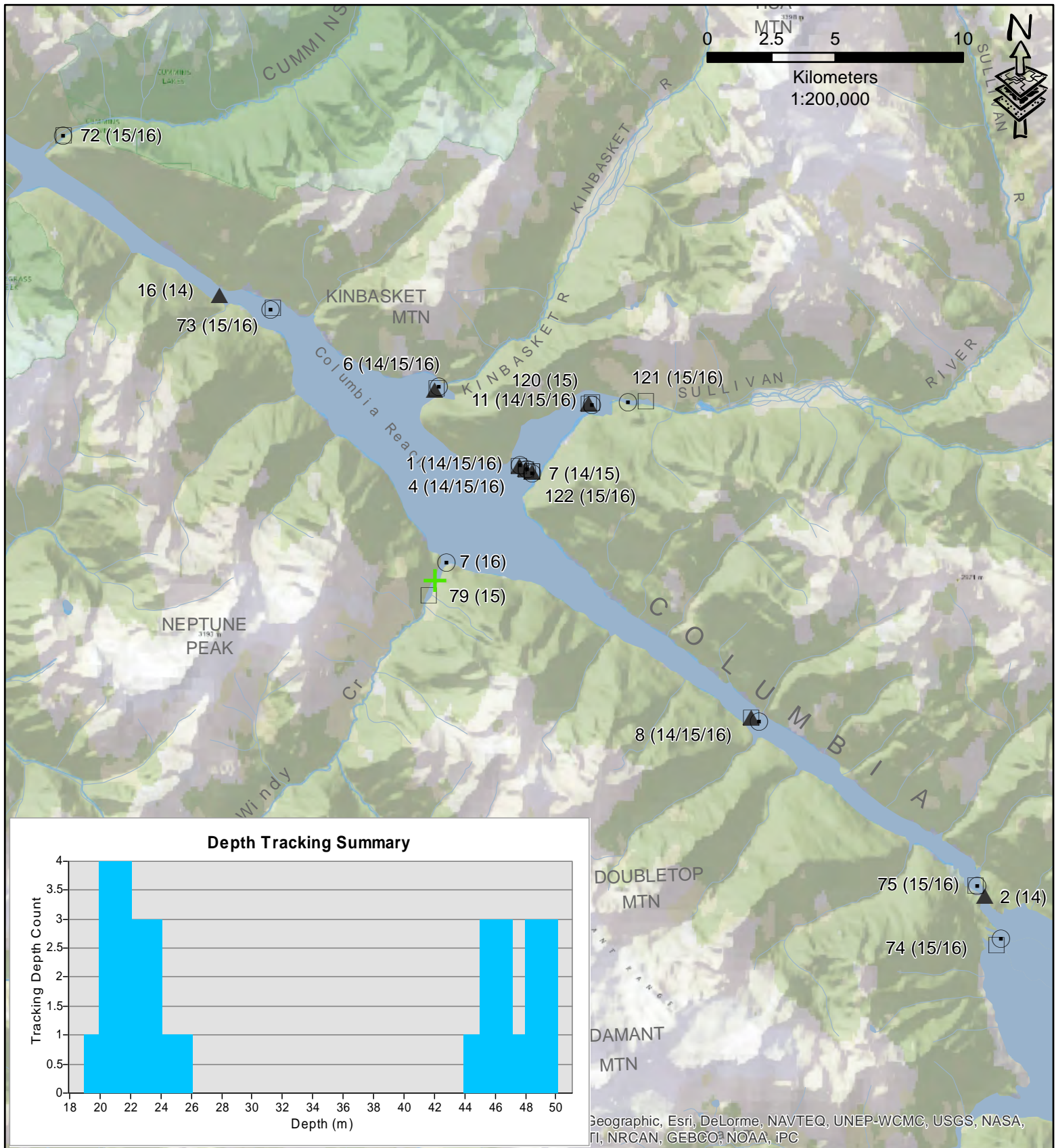
- Receiver - Tracking Location (Year)
- ▲ 2014
- ⊕ Capture Location
- 2015
- 2016

**Kinbasket Reservoir Burbot Tracking**  
**Acoustic Code: 38300**

Note: Missing location receiver 114, 115, 118

Receiver ID	1	4	8	114	115	118	121	122
Tracking Count	205	366	7	31	283	21	530	238
Tracking Date Range	30/10/2015 to 23/12/2015	30/10/2015 to 23/12/2015	24/12/2015 to 24/12/2015	06/01/2016 to 07/01/2016	25/12/2015 to 05/01/2016	10/01/2016 to 11/01/2016	22/07/2015 to 20/10/2015	05/11/2015 to 23/12/2015
Depth Range	13m - 35m	13m - 35m	21m - 27m	13m - 19m	19m - 30m	8m - 11m	2m - 12m	14m - 34m
Average Depth	25.2m	25.1m	25.7m	14.8m	23.4m	8.8m	6.8m	26.1m





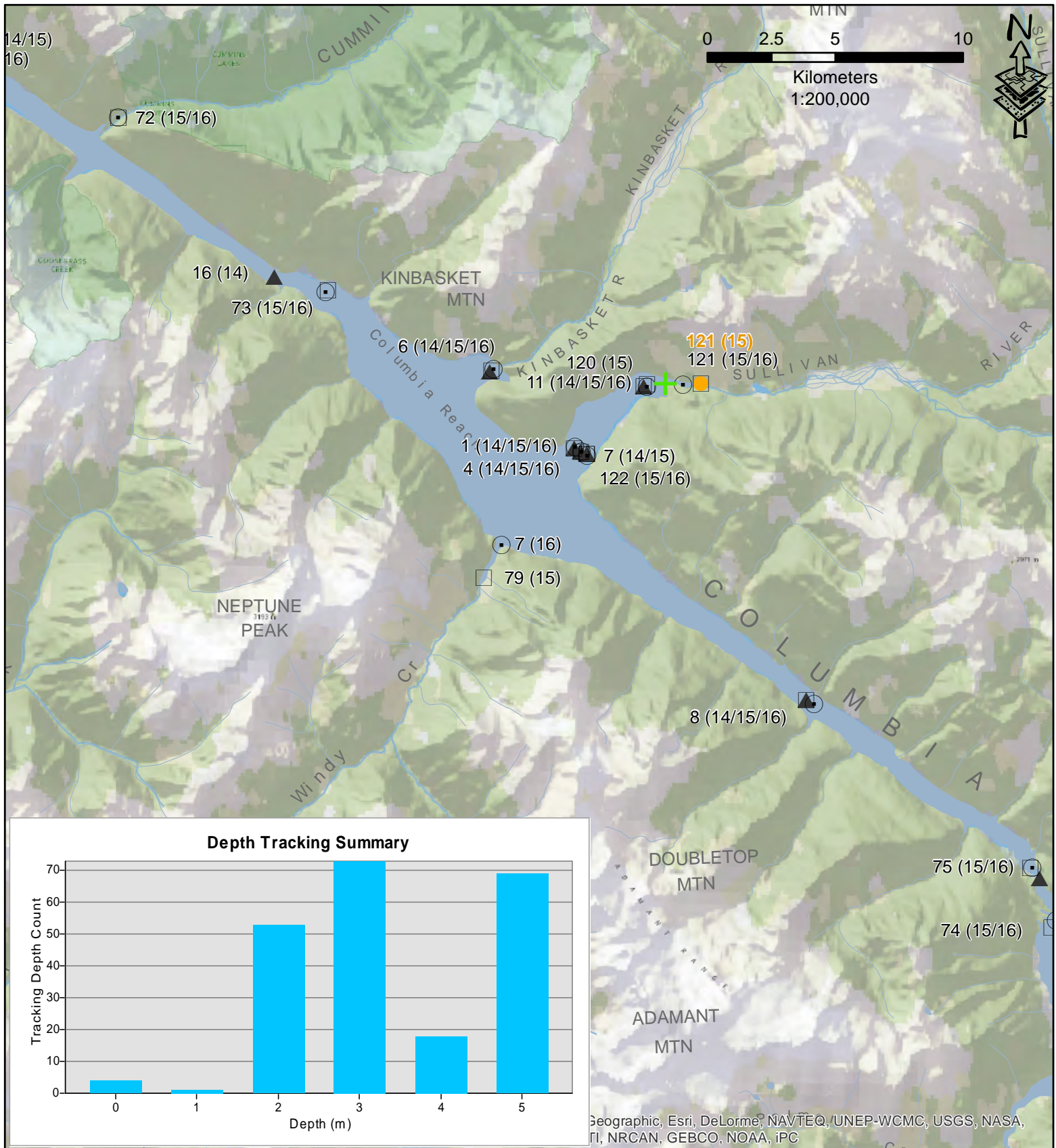
### Kinbasket Reservoir Burbot Tracking Acoustic Code: 38400

- + Capture Location
- Receiver Location (Year)
  - ▲ 2014
  - 2015
  - 2016

Receiver ID	113
Tracking Count	19
Tracking Date Range	04/04/2016 to 19/04/2016
Depth Range	20m - 49m
Average Depth	32.7m

Note: Missing location receiver 113



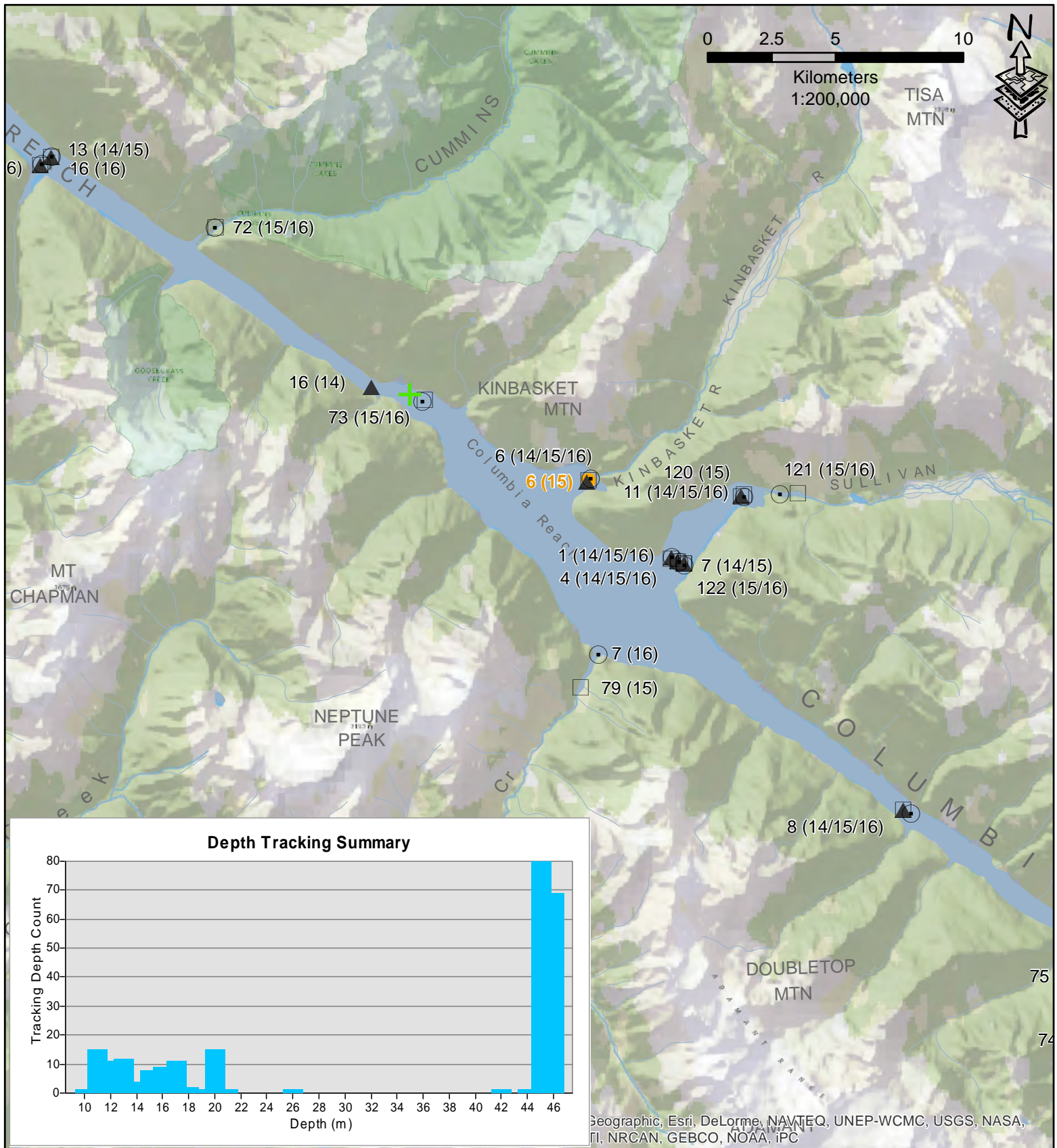


### Kinbasket Reservoir Burbot Tracking Acoustic Code: 38500

- Receiver - Tracking Location (Year)
- ▲ 2014
- ⊕ Capture Location
- 2015
- ⊙ 2016

Receiver ID	121
Tracking Count	218
Tracking Date Range	23/07/2015 to 26/12/2015
Depth Range	0m - 5m
Average Depth	3.4m



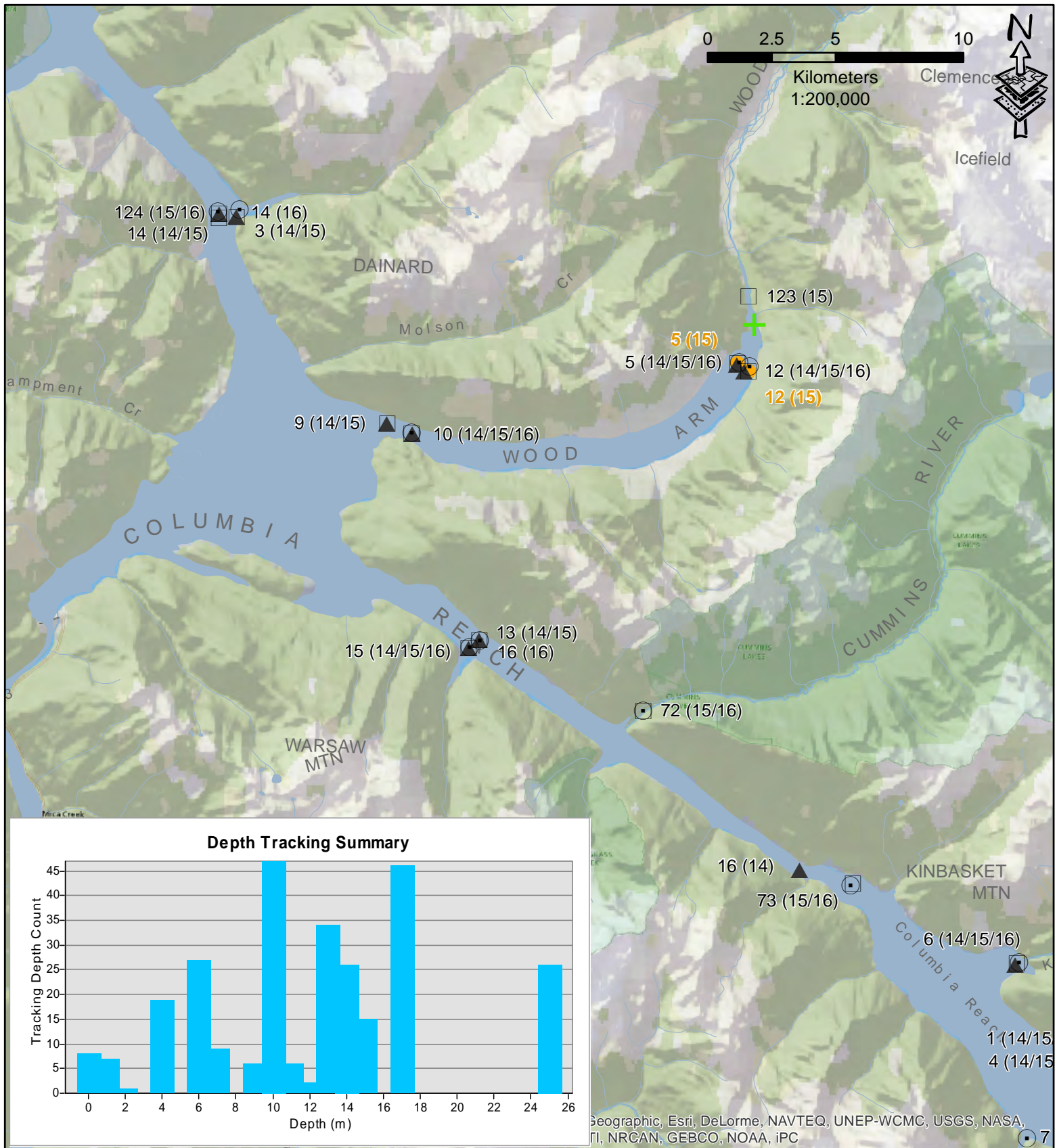


### Kinbasket Reservoir Burbot Tracking Acoustic Code: 38700

- Receiver - Tracking Location (Year)
- ▲ 2014
- ⊕ Capture Location
- 2015
- ⊙ 2016

Receiver ID	6
Tracking Count	242
Tracking Date Range	04/06/2015 to 20/06/2015
Depth Range	10m - 46m
Average Depth	34.m



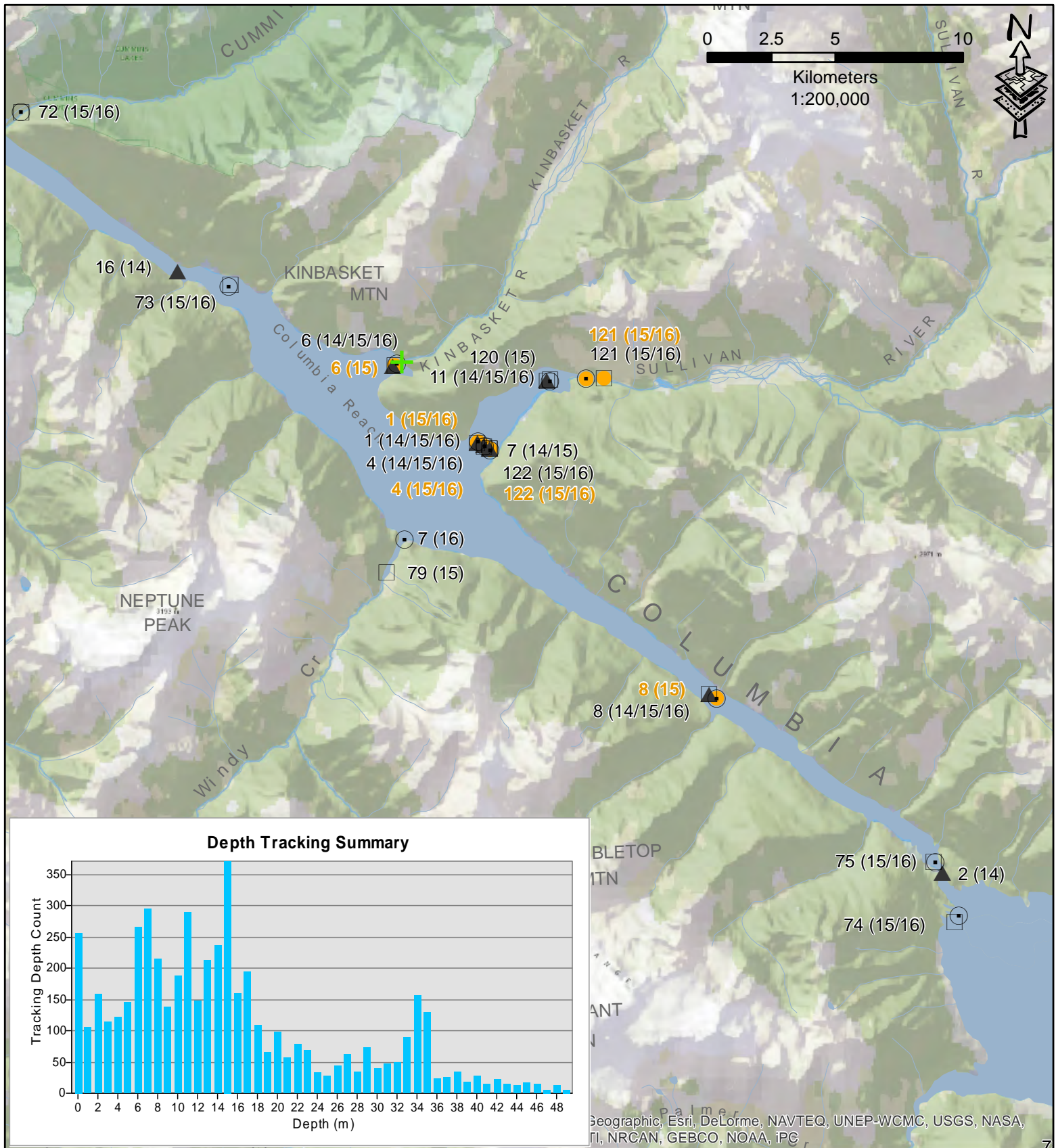


### Kinbasket Reservoir Burbot Tracking Acoustic Code: 38900

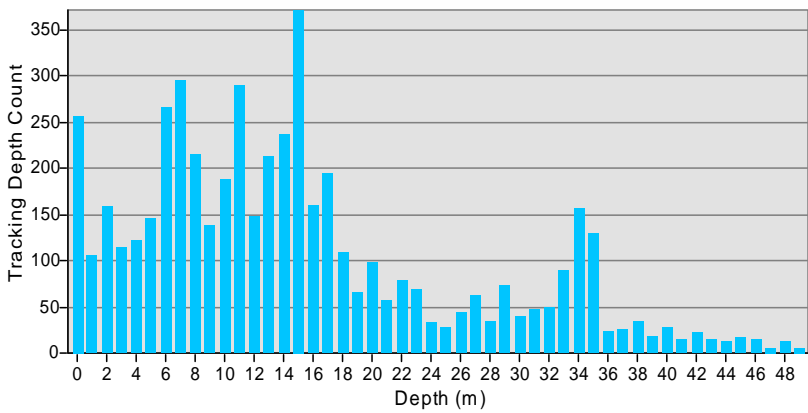
- Receiver - Tracking Location (Year)
- ▲ 2014
- ⊕ Capture Location
- 2015
- ⊙ 2016

Receiver ID	5	12
Tracking Count	238	41
Tracking Date Range	05/08/2015 to 09/08/2015	20/06/2015 to 09/08/2015
Depth Range	0m - 25m	0m - 25m
Average Depth	12.6m	9.3m





**Depth Tracking Summary**

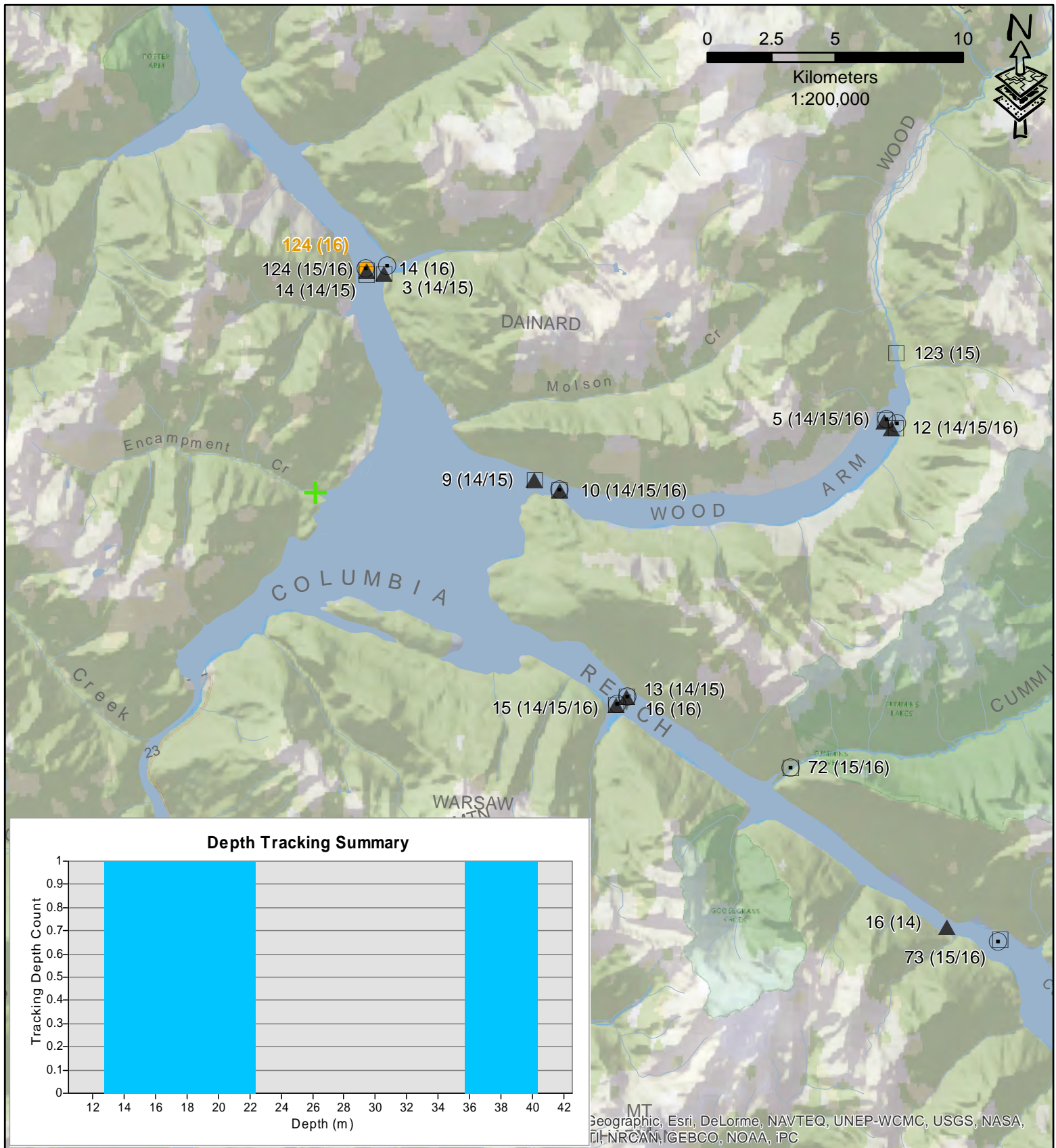


- Receiver - Tracking Location (Year)
- ▲ 2014
- ⊕ Capture Location
- 2015
- ⊙ 2016

**Kinbasket Reservoir Burbot Tracking**  
**Acoustic Code: 39000**  
 Note: Missing location receiver 113

Receiver ID	1	4	6	8	113	121	122
Tracking Count	24	58	4610	33	3	356	50
Tracking Date Range	29/12/2015 to 08/03/2016	29/12/2015 to 02/05/2016	21/05/2015 to 28/12/2015	01/04/2016 to 01/04/2016	07/04/2016 to 10/04/2016	31/12/2015 to 14/01/2016	29/12/2015 to 02/05/2016
Depth Range	4m - 35m	2m - 37m	0m - 49m	4m - 29m	26m - 49m	0m - 4m	2m - 37m
Average Depth	19.3m	18.9m	16.m	20.9m	39.3m	.6m	17.2m

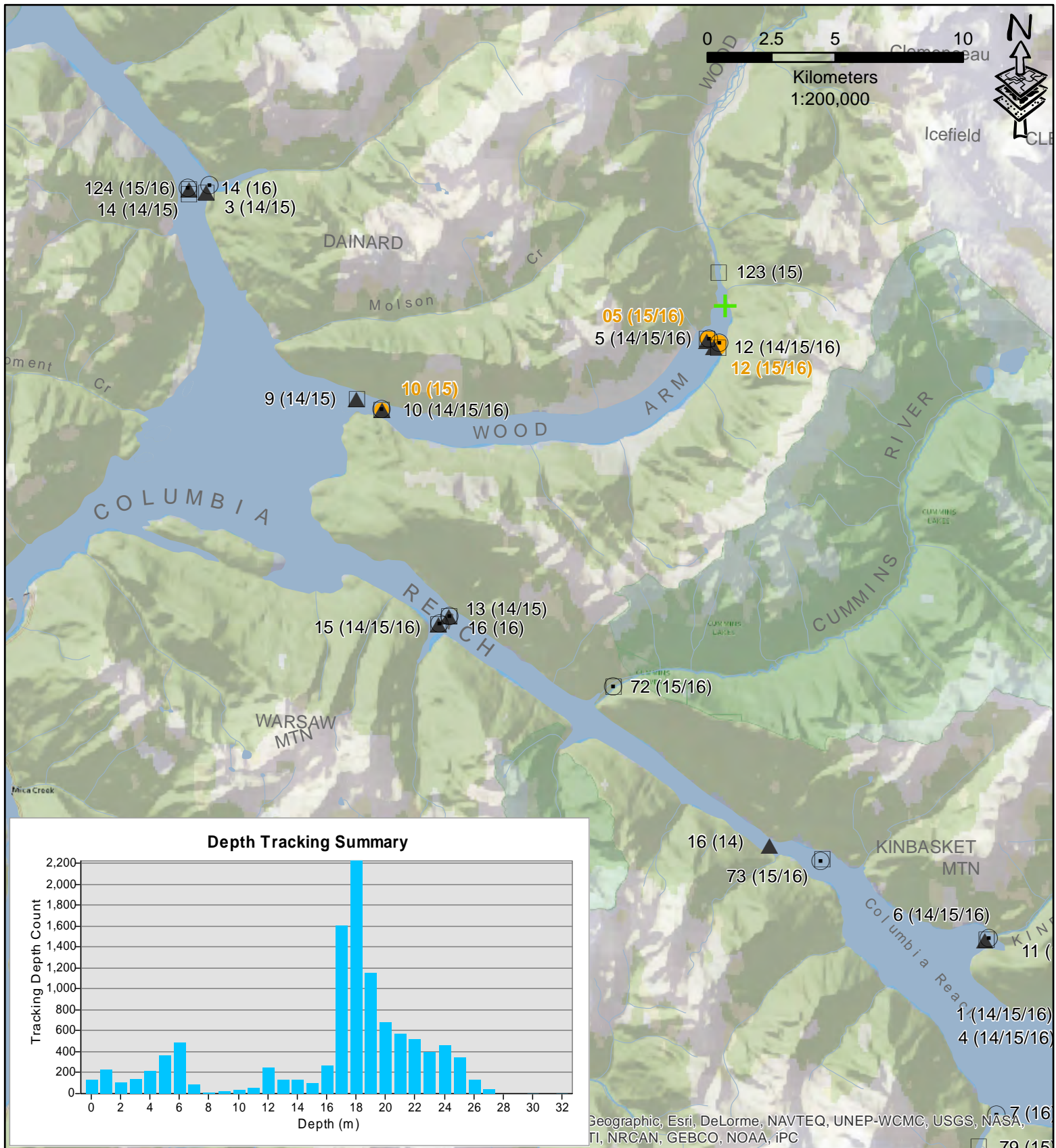




### Kinbasket Reservoir Burbot Tracking Acoustic Code: 39100

- Receiver - Tracking Location (Year)
- ▲ 2014
- ⊕ Capture Location
- 2015
- ⊙ 2016

<b>Receiver ID</b>	124
<b>Tracking Count</b>	4
<b>Tracking Date Range</b>	04/03/2016 to 06/03/2016
<b>Depth Range</b>	15m - 38m
<b>Average Depth</b>	22.8m

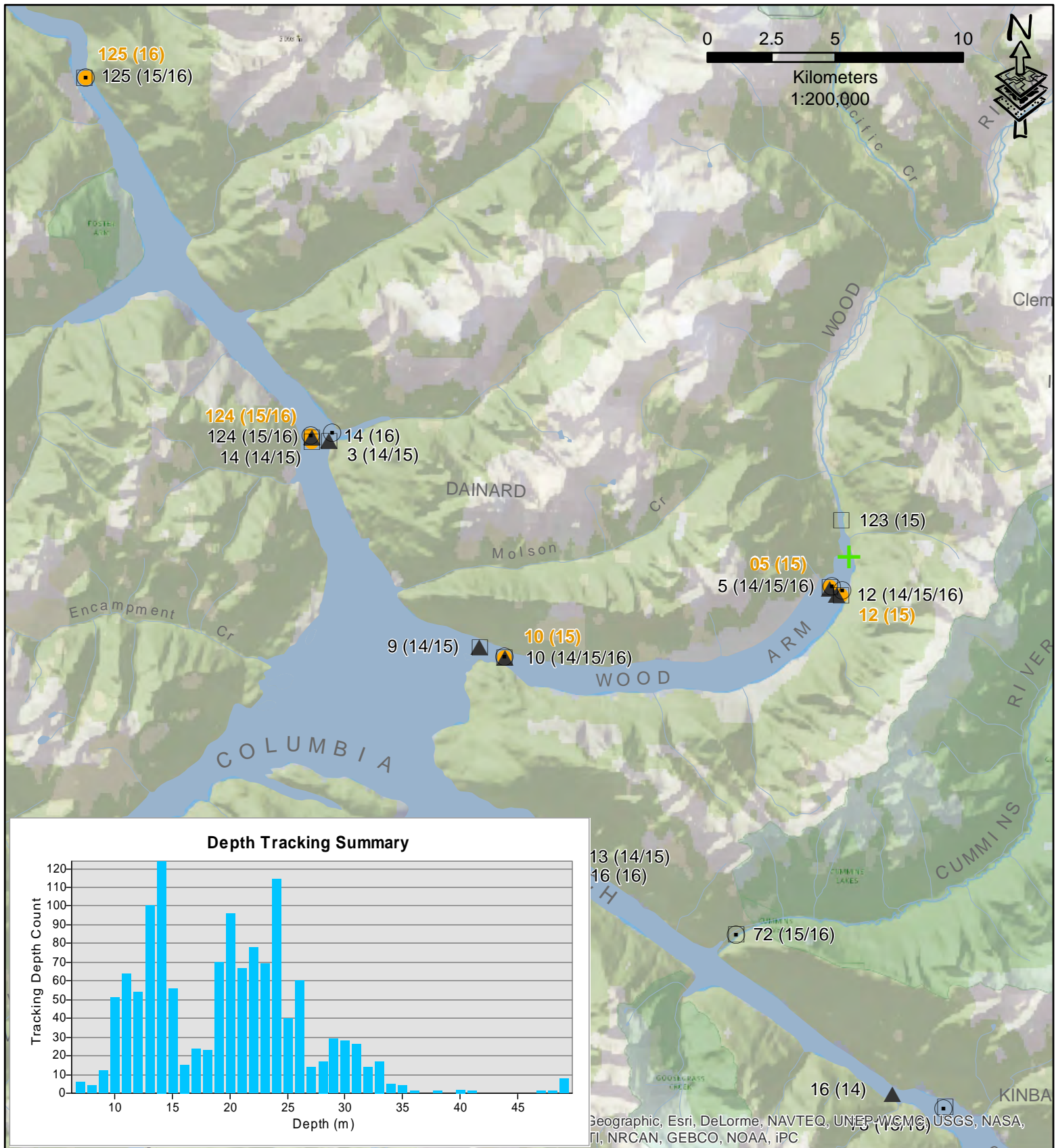


### Kinbasket Reservoir Burbot Tracking Acoustic Code: 39200

- Receiver - Tracking Location (Year)
- ▲ 2014
- + Capture Location
- 2015
- 2016

Receiver ID	5	10	12
<b>Tracking Count</b>	4691	294	5924
<b>Tracking Date Range</b>	14/05/2015 to 14/04/2016	11/09/2015 to 19/10/2015	14/05/2015 to 20/03/2016
<b>Depth Range</b>	0m - 27m	9m - 32m	0m - 27m
<b>Average Depth</b>	17.m	17.6m	16.2m





● Receiver - Tracking Location (Year)

✚ Capture Location

Receiver Location (Year)

▲ 2014

□ 2015

◉ 2016

### Kinbasket Reservoir Burbot Tracking Acoustic Code: 39300

Receiver ID	5	10	12	124	125
Tracking Count	470	11	788	22	5
Tracking Date Range	09/06/2015 to 12/11/2015	27/11/2015 to 27/11/2015	09/06/2015 to 20/11/2015	29/11/2015 to 15/03/2016	14/04/2016 to 14/04/2016
Depth Range	7m - 30m	30m - 47m	7m - 34m	26m - 49m	7m - 35m
Average Depth	18.3m	35.6m	19.8m	39.4m	14.2m

APPENDIX 3: Mean daily depths of each Burbot during all monitoring periods (June 2014 to May 2016) in Kinbasket Reservoir (n=84, includes depth profiles of 12 Burbot suspected or confirmed to be dead). Spawning is expected to occur January (01/2015 or 01/2016) to April (04/2015 or 04/2016).

