

Data Expedition: Satellite Tagging Records of Deep Divers off Cape Hatteras, North Carolina



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What's a data expedition?

Duke UNIVERSITY | INFORMATION INITIATIVE at DUKE (iiD)

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iiD Engage with big data at Duke.

The Information Initiative at Duke brings disciplines together to unlock the potential of big data. [Learn more about iiD.](#)

Give undergraduates the tools to work with large data sets in the context of traditional courses

Use open-source software to manipulate, analyze, and visualize a large data set of behavioral information

Comparing two deep-diving species



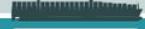
Short-finned pilot whales (*Globicephala macrorhynchus*)



Cuvier's beaked whale (*Ziphius cavirostris*)

Size of theoretical football at sea surface experiencing pressure of one atmosphere

Maersk Triple E Class Ship
one of the largest ships in the world



400m

0m

264m

741m

828m

1,019m

1,408m

1,453m

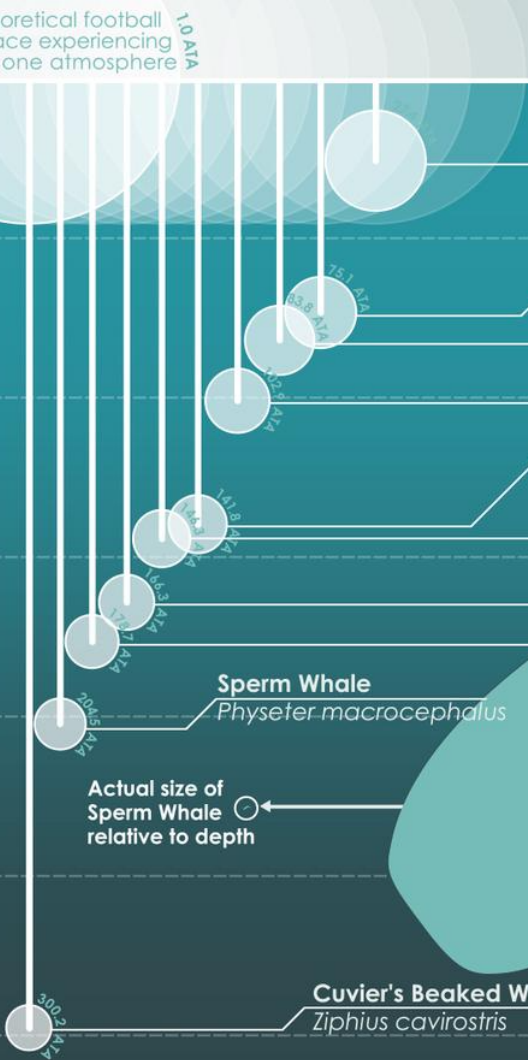
1,653m

1,777m

2,035m

DEPTH (metres)

2,992m



Killer Whale
Orcinus orca



Weddell Seal
Leptonychotes weddellii



Long-finned Pilot Whale
Globicephala melas



Short-finned Pilot Whale
Globicephala macrorhynchus



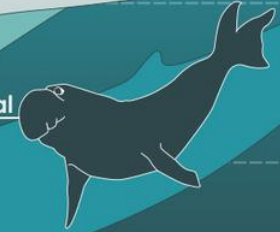
Blainville's Beaked Whale
Mesoplodon densirostris



Northern Bottlenose Whale
Hyperoodon ampullatus



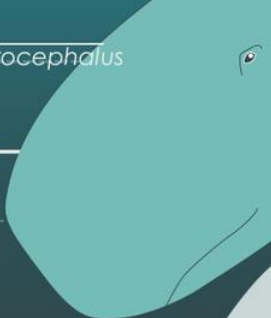
Southern Elephant Seal
Mirounga leonina



Baird's Beaked Whale
Berardius bairdii



Sperm Whale
Physeter macrocephalus



Actual size of Sperm Whale relative to depth

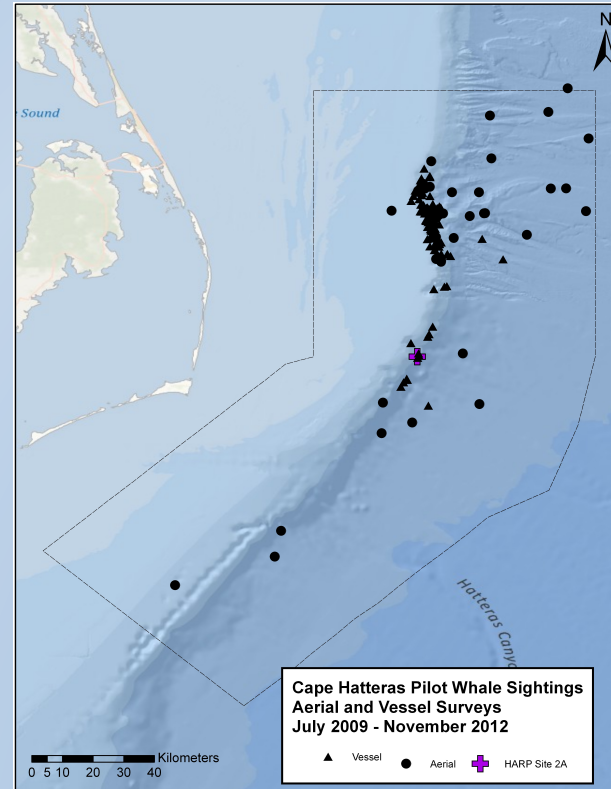
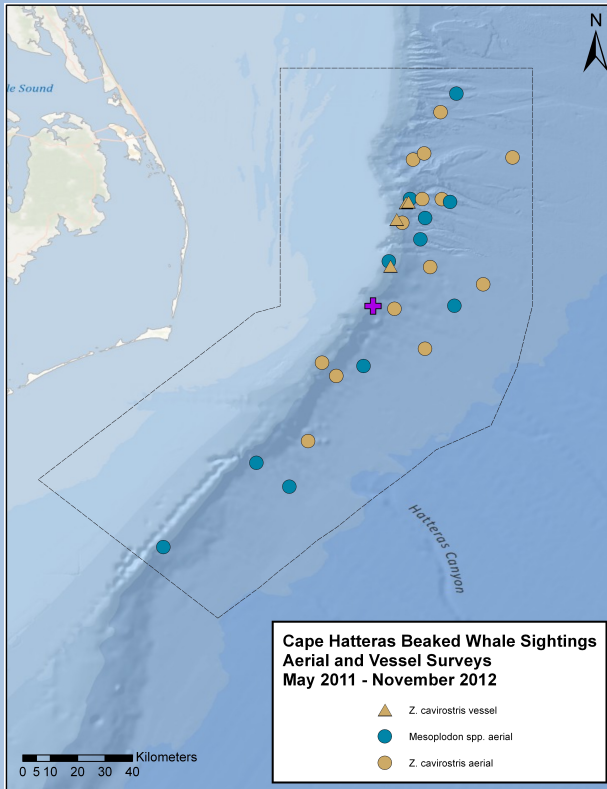
Cuvier's Beaked Whale
Ziphius cavirostris



Most extreme diving mammals

BBC earth

© pierangelo pirak / bbc earth





GmTag093



GmTag085



GmTag100



GmTag123



GmTag098



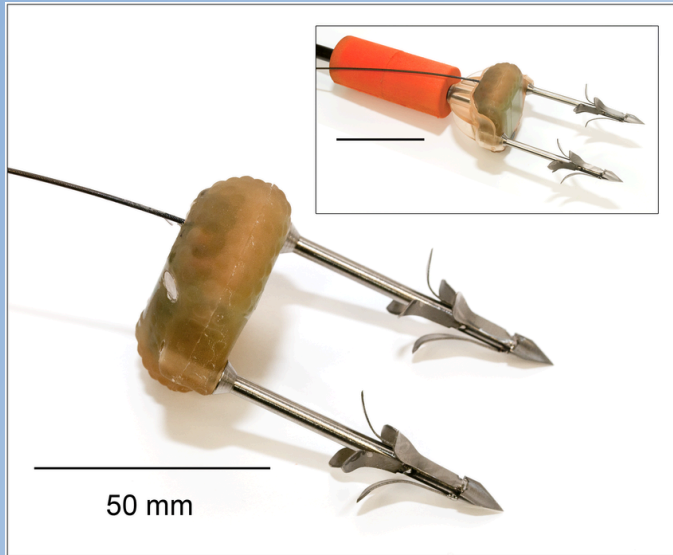
ZcTag030



ZcTag031



MK-10A LIMPET Tags



Last 2-10 weeks

Direct output:

- Location
- Time
- Depth (pressure)
- Conductivity (wet/dry)

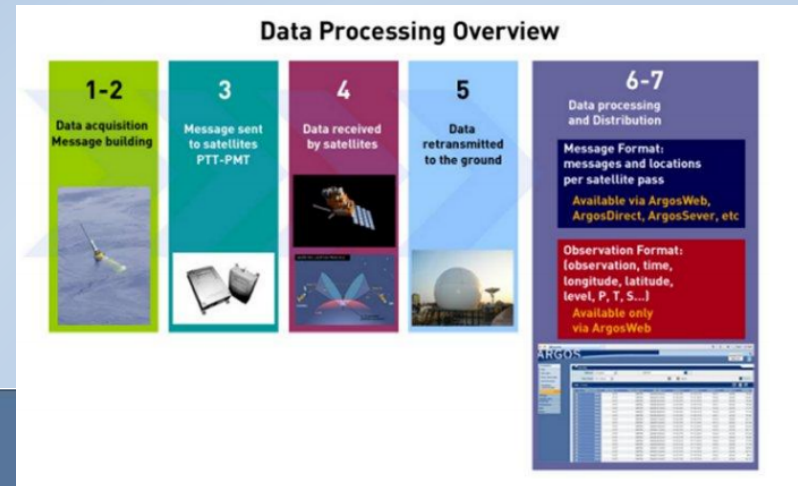
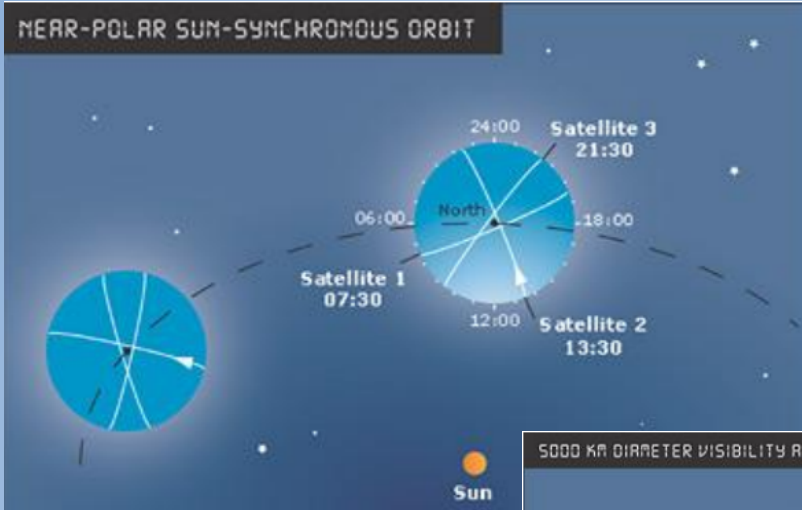
Indirect output:

- Dive shape
- Dive duration

Uses ARGOS to transmit



ARGOS



Behavior Data

- Message blocks – about 5 dives
- Dives
 - Minimum dive threshold
 - 75 meters
 - 30 seconds
 - Dive duration
 - Maximum dive depth
 - Shape (Square, “V”, “U”)
- Surface
 - Duration

Potential Errors

- Sensor drift or failure
 - Wet/dry sensor
 - Pressure sensor
- Uplink failure
 - Can't connect to satellite
- Buffer overload
 - Can't store more data in memory

Definitions

- PTT: Platform Terminal Transmitters
- Pressure: The unit force per square inch. Can be converted to a depth in sea water.
- Depth: Distance below the surface.
- Argos: A satellite based tracking and data collection system (www.argos-system.org).
- Sample: A single reading from a sensor.
- Sample rate: Samples measured per unit time. For example, 0.5 samples per second.
- Sample interval: The time between samples, also the inverse of sample rate. For example a 2 second sample interval is equivalent to sample rate 0.5 samples per second.
- Duty cycle: Enabling and disabling functionality of the tag during a deployment. This is typically done to save power or conserve data memory, and thus extend the total duration of a deployment.
- Wet/Dry sensor: Sensor on a tag which can determine if the tag is in or out of sea water. Unique settings are required for brackish or freshwater.
- GMT: Greenwich Mean Time. Global time standard that is based on the mean position of the sun at noon at 0 degrees longitude. On Wildlife Computers tags, this is functionally equivalent to UTC and UT1.

Font: Calibri (Body) 12, Bold, Italic, Underline, Text Color, Background Color

Alignment: Left, Center, Right, Justify, Wrap Text, Merge

Number: General, Currency, Percentage, Decimals

Format: Normal, Bad

Conditional Formatting, Insert, Delete

20 fx 1

TagID	Ptt	DepthSensor	Source	Instr	Count	Start	End	What	Number	Shape	DepthMin	DepthMax	DurationMin	DurationMax
g127	94814	1	Transmissio	Mk10	16	5/19/15 8:53 PM	5/19/15 10:15 PM	Message	10				4932	4952
g127	94814	1	Transmissio	Mk10	16	5/19/15 8:53 PM	5/19/15 8:57 PM	Dive	1	Square	51	52	287	287
g127	94814	1	Transmissio	Mk10	16	5/19/15 8:57 PM	5/19/15 9:14 PM	Surface					1023	1023
g127	94814	1	Transmissio	Mk10	16	5/19/15 9:14 PM	5/19/15 9:23 PM	Dive	1	U	300	307	537	537
g127	94814	1	Transmissio	Mk10	16	5/19/15 9:23 PM	5/19/15 9:27 PM	Surface					231	231
g127	94814	1	Transmissio	Mk10	16	5/19/15 9:27 PM	5/19/15 9:27 PM	Dive	1	U	150	153	581	581
g127	94814	1	Transmissio	Mk10	16	5/19/15 9:27 PM	5/19/15 9:27 PM	Dive	1	U			197	197
g127	94814	1	Transmissio	Mk10	16	5/19/15 9:27 PM	5/19/15 9:27 PM	Dive	1	U	97	98	625	625
g127	94814	1	Transmissio	Mk10	16	5/19/15 9:51 PM	5/19/15 9:54 PM	Surface					175	175
g127	94814	1	Transmissio	Mk10	16	5/19/15 10:04 PM	5/19/15 10:04 PM	Dive	1	Square	39	39	599	600
g127	94814	1	Transmissio	Mk10	16	5/19/15 10:04 PM	5/19/15 10:15 PM	Surface					677	677
g127	94814	1	Transmissio	Mk10	16	5/19/15 10:15 PM	5/20/15 12:08 AM	Message	10				6818	6832
g127	94814	1	Transmissio	Mk10	16	5/19/15 10:15 PM	5/19/15 10:15 PM	Dive	1	U	252	259	497	497
g127	94814	1	Transmissio	Mk10	15	5/19/15 10:23 PM	5/19/15 10:28 PM	Surface					303	303
g127	94814	1	Transmissio	Mk10	15	5/19/15 10:28 PM	5/19/15 10:37 PM	Dive	1	Square	49	50	551	551
g127	94814	1	Transmissio	Mk10	15	5/19/15 10:47 PM	5/19/15 10:47 PM	Dive	1	Square	42	42	601	601
g127	94814	1	Transmissio	Mk10	15	5/19/15 10:47 PM	5/19/15 10:54 PM	Dive	1	Square	42	42	419	420
g127	94814	1	Transmissio	Mk10	15	5/19/15 10:58 PM	5/19/15 10:58 PM	Surface					2055	2055
g127	94814	1	Transmissio	Mk10	15	5/19/15 11:36 PM	5/19/15 11:36 PM	Surface					471	471
g127	94814	1	Transmissio	Mk10	15	5/19/15 11:36 PM	5/19/15 11:58 PM	Surface					1333	1333
g127	94814	1	Transmissio	Mk10	15	5/19/15 11:58 PM	5/20/15 12:05 AM	Dive	1	U	158	161	415	415
g127	94814	1	Transmissio	Mk10	15	5/20/15 12:05 AM	5/20/15 12:08 AM	Surface					173	173
g127	94814	1	Transmissio	Mk10	8	5/20/15 12:09 AM	5/20/15 2:17 AM	Message	10				7702	7722
g127	94814	1	Transmissio	Mk10	8	5/20/15 12:09 AM	5/20/15 12:15 AM	Dive	1	V	77	78	361	361
g127	94814	1	Transmissio	Mk10	8	5/20/15 12:15 AM	5/20/15 12:39 AM	Surface					1489	1489
g127	94814	1	Transmissio	Mk10	8	5/20/15 12:39 AM	5/20/15 12:46 AM	Dive	1	Square	32	32	415	415
g127	94814	1	Transmissio	Mk10	8	5/20/15 12:46 AM	5/20/15 1:21 AM	Surface					2065	2065
g127	94814	1	Transmissio	Mk10	8	5/20/15 1:21 AM	5/20/15 1:28 AM	Dive	1	U	51	52	431	431
g127	94814	1	Transmissio	Mk10	8	5/20/15 1:28 AM	5/20/15 1:33 AM	Surface					291	291
g127	94814	1	Transmissio	Mk10	8	5/20/15 1:33 AM	5/20/15 1:48 AM	Dive	1	U	632	647	917	917
g127	94814	1	Transmissio	Mk10	8	5/20/15 1:48 AM	5/20/15 1:55 AM	Surface					401	401
g127	94814	1	Transmissio	Mk10	8	5/20/15 1:55 AM	5/20/15 2:10 AM	Dive	1	U	680	695	931	931
g127	94814	1	Transmissio	Mk10	8	5/20/15 2:10 AM	5/20/15 2:17 AM	Surface					401	401
g127	94814	1	Transmissio	Mk10	5	5/20/15 2:17 AM	5/20/15 4:23 AM	Message	9				7575	7595
g127	94814	1	Transmissio	Mk10	5	5/20/15 2:17 AM	5/20/15 2:33 AM	Dive	1	U	364	371	975	975
g127	94814	1	Transmissio	Mk10	5	5/20/15 2:33 AM	5/20/15 2:33 AM	Surface					2252	2252

- 30 tags from 2014-2017
- 19 pilot whale
- 11 beaked whale
- Tags lasted 2-64 days
- Deployed May through October

DataExpedition_SatTagPlotting.R

```

1 > #####
2 #                               Data Expedition 2017                               #
3 # Satellite Tagging Records of Deep Divers off Cape Hatteras, North Carolina #
4 > #####
5
6 > #####
7 > #### Part I: Clean Tag Data ####
8 > #####
9
10 #Make sure you've already installed these packages before starting ('Tools'--> 'Install Packages', once
    installed, you'll still need to run library function)
11 library(ggplot2)
12 library(plyr)
13
14 load("alltags_raw.RData")
15
16 #Check for too short durations for deep dives (max speed with buffer)
17 #Assign max speed from literature
18 #Tyack et al. 2006 says average vertical speed around 1.6m/s
19 max_speed<-3 #meters per second
20 max_duration<-120 #min
21 #Average descent speed ~1.5m/s, max around 2m/s
22
23 ### 1. Use equation to flag points where dive is too fast or too long ###
24
25 > for (i in 1:length(alltags_raw)){
26
27   ctag<-alltags_raw[[i]]
28
29   ctag$DurationMin<-as.numeric(ctag$DurationMin)/60 #in minutes
30
31   ctag$lv<-(-60*max_speed)*ctag$DurationMin

```

11:1 (Untitled)

R Script

Environment History

Import Dataset

Global Environment

Environment is empty

Files Plots Packages Help Viewer

Zoom

Export

Console ~/Documents/Work_School/Coursework/DataExpeditions/Fall 2017/Class_Runthrough/

Platform: x86_64-apple-darwin15.6.0 (64-bit)

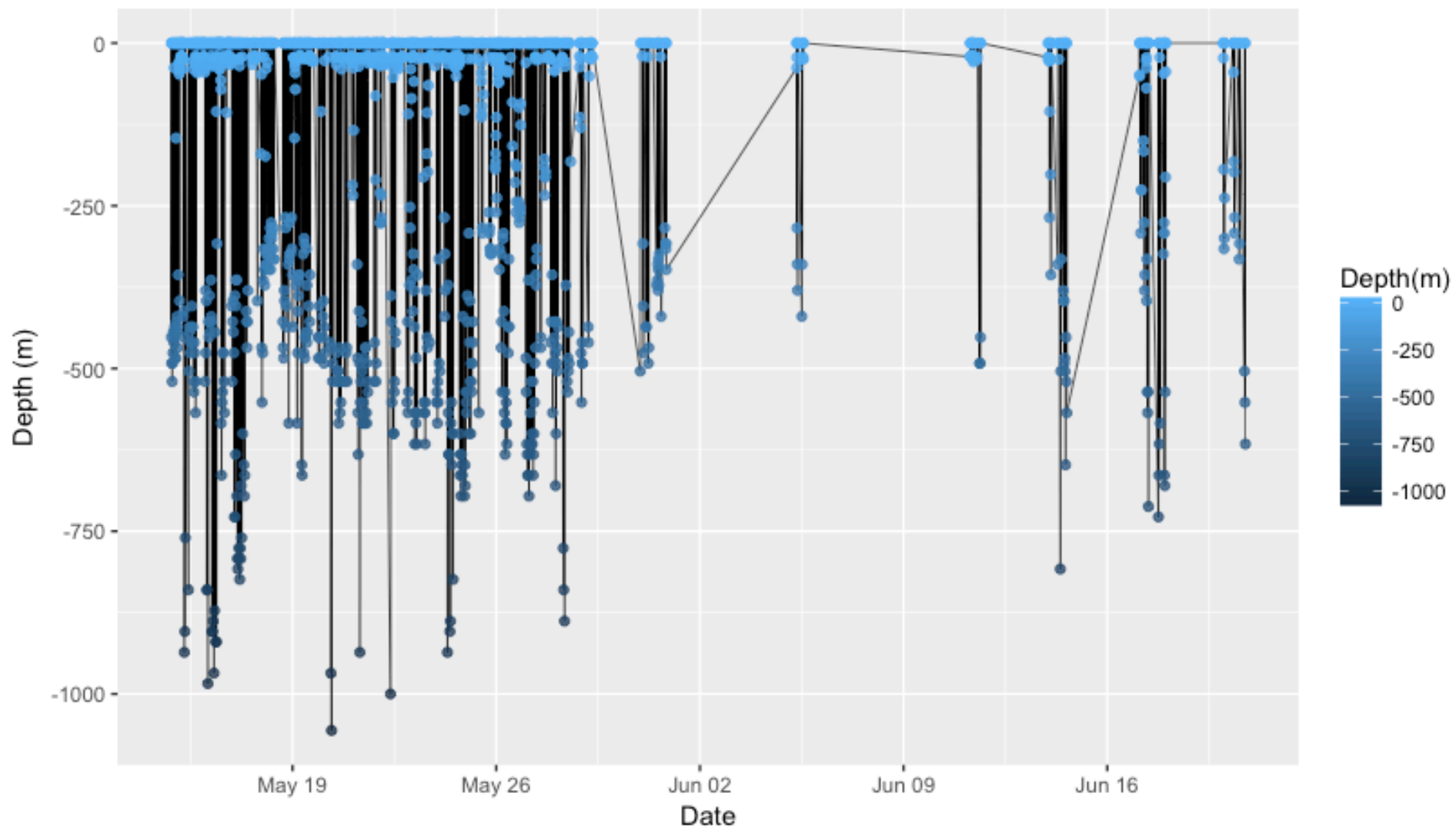
R is free software and comes with ABSOLUTELY NO WARRANTY.
 You are welcome to redistribute it under certain conditions.
 Type 'license()' or 'licence()' for distribution details.

Natural language support but running in an English locale

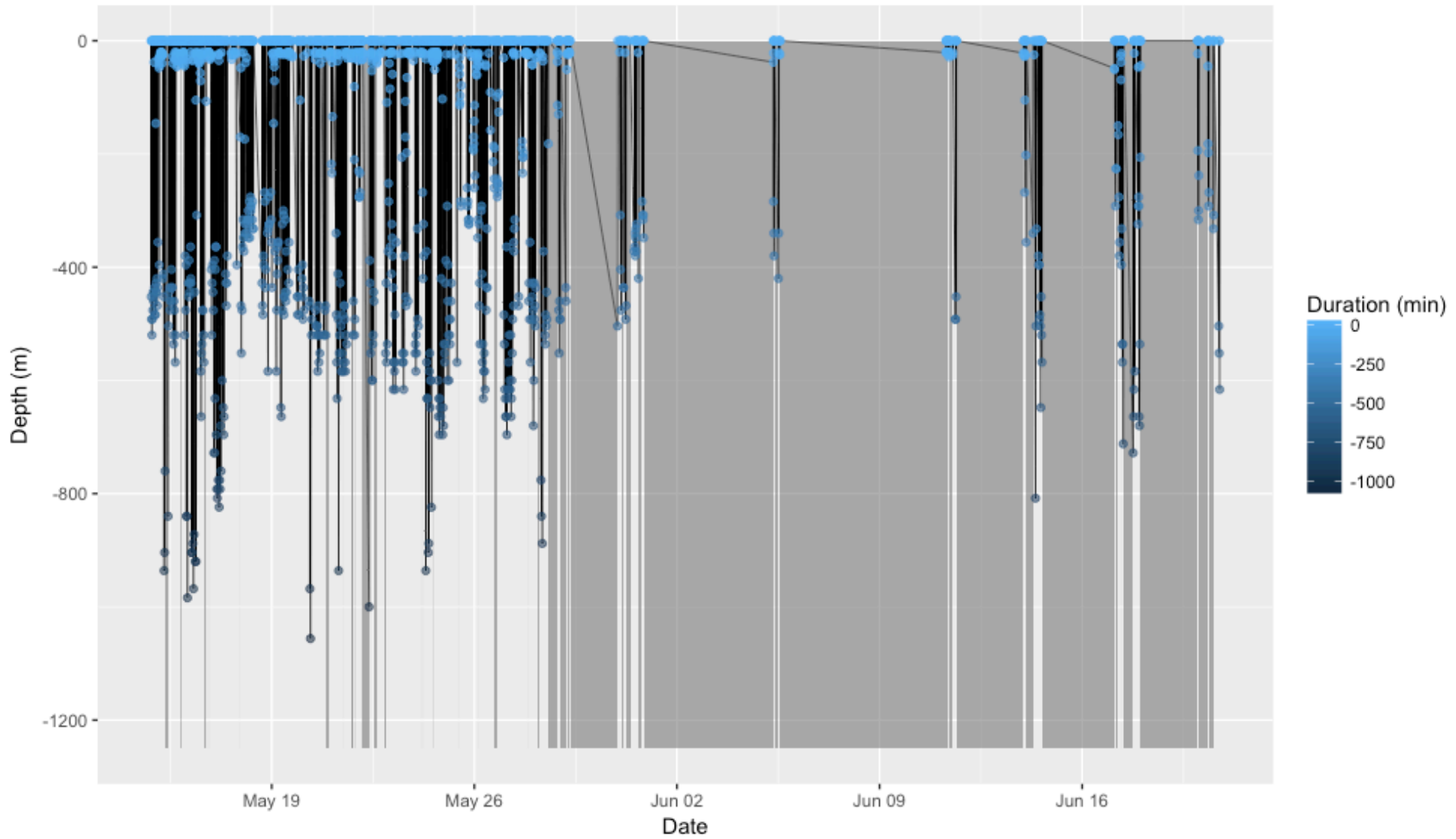
R is a collaborative project with many contributors.
 Type 'contributors()' for more information and
 'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos. 'help()' for on-line help or

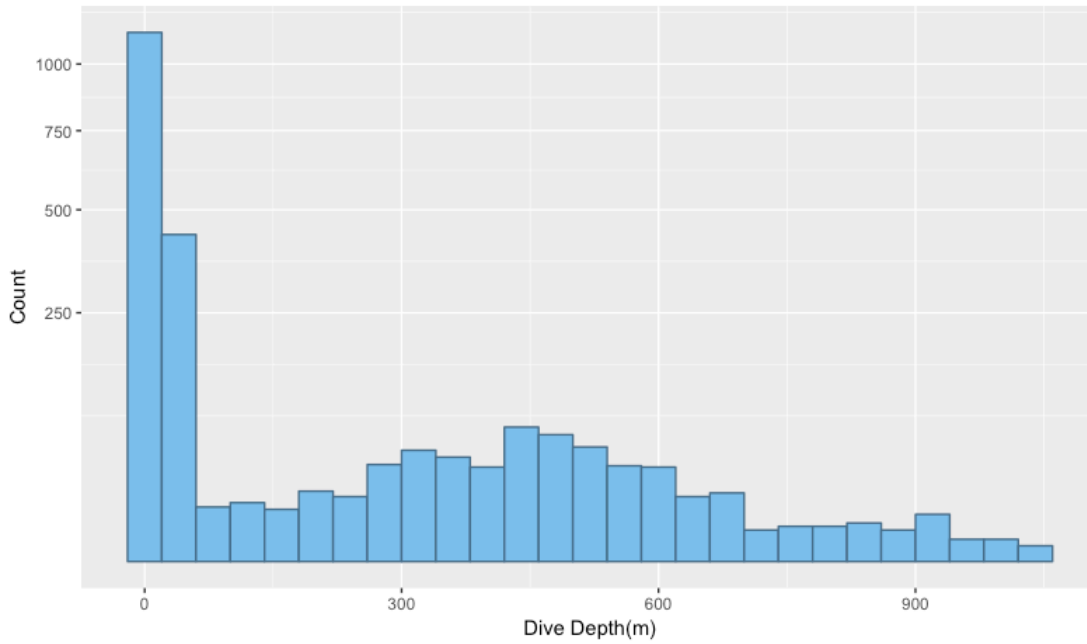
GmTag085



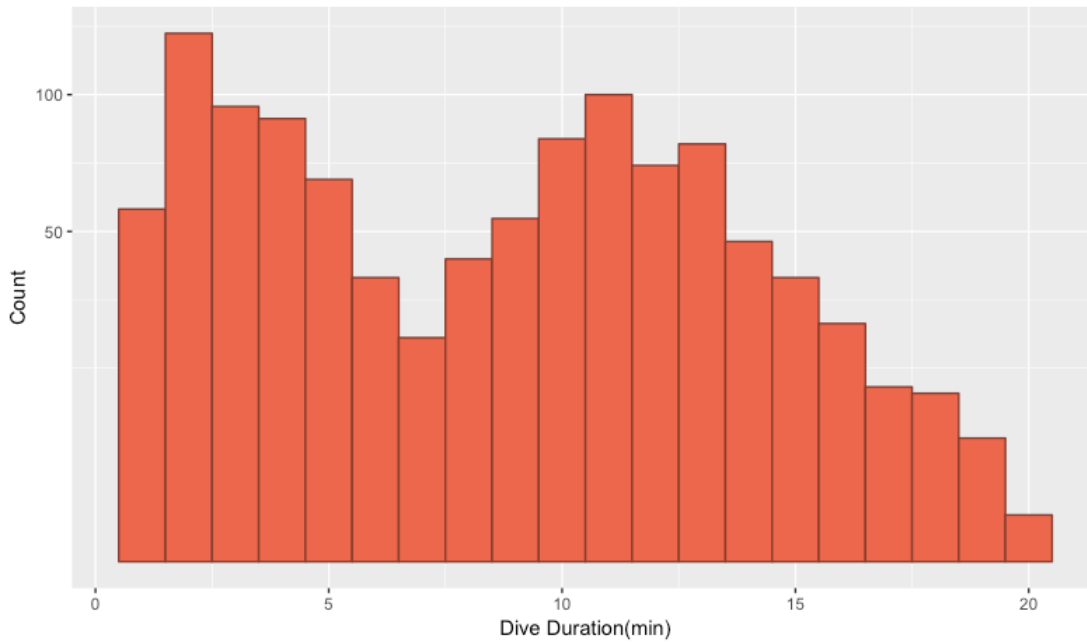
GmTag085



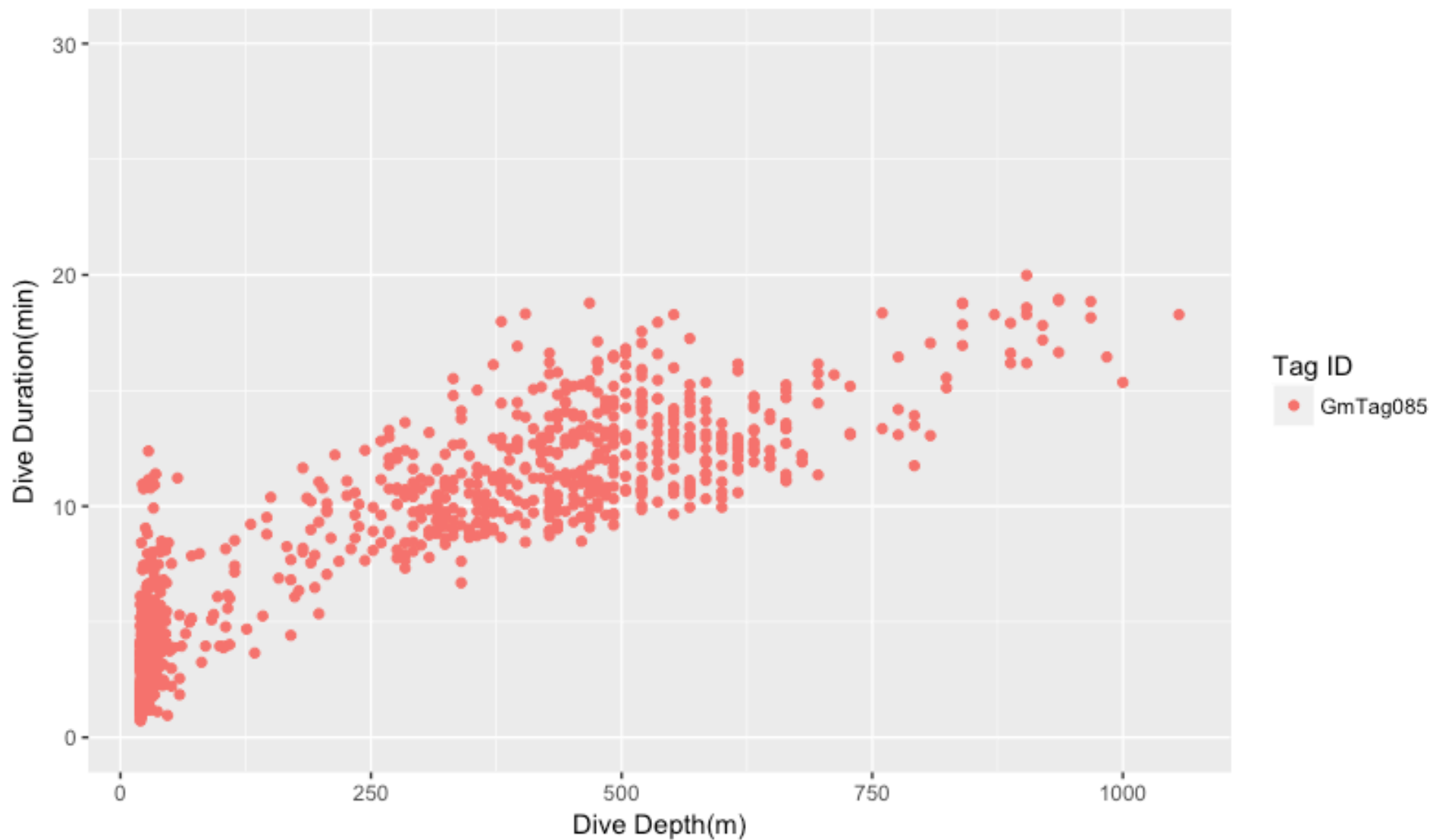
GmTag085 Dive Depth Distribution



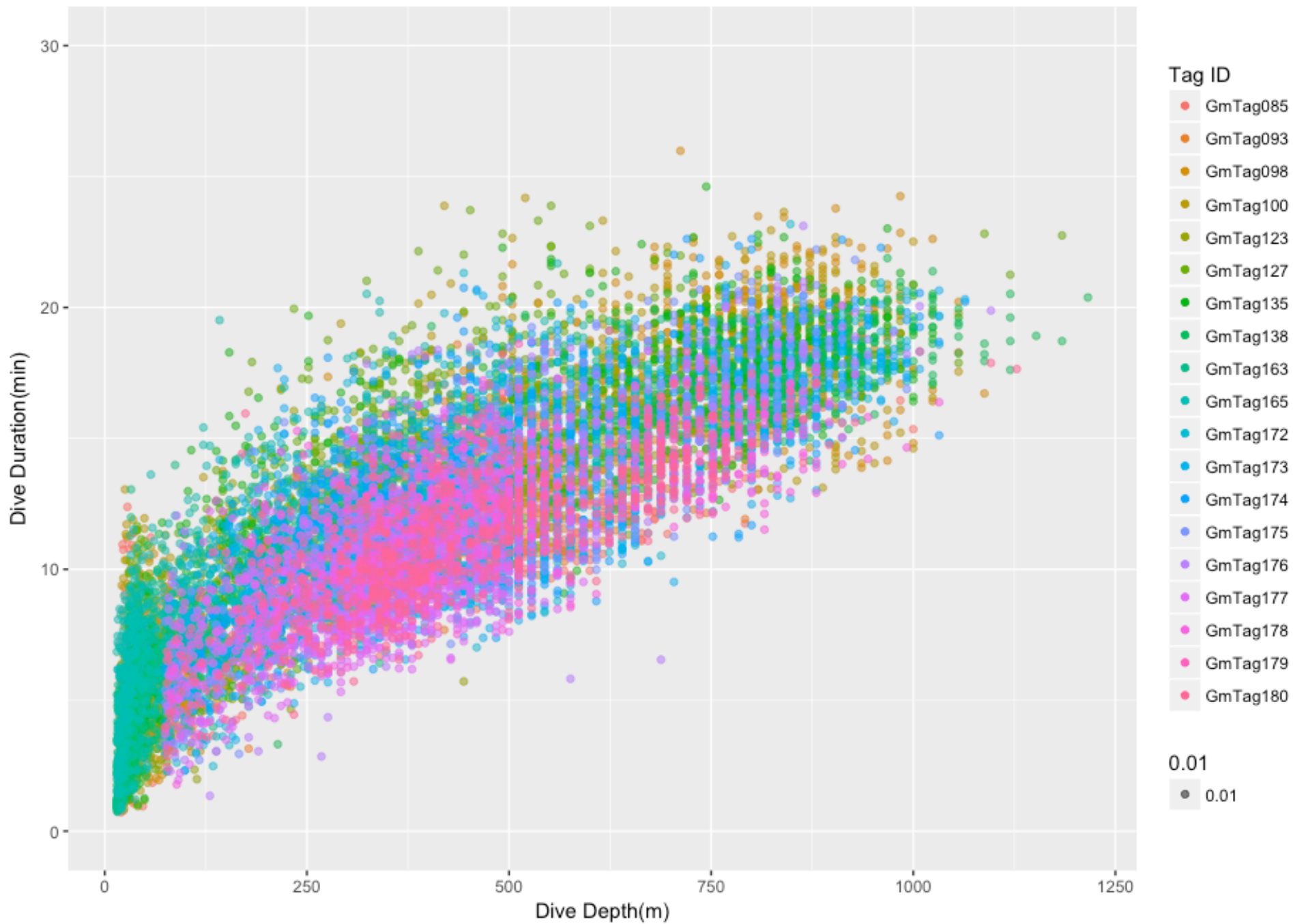
GmTag085 Dive Duration Distribution



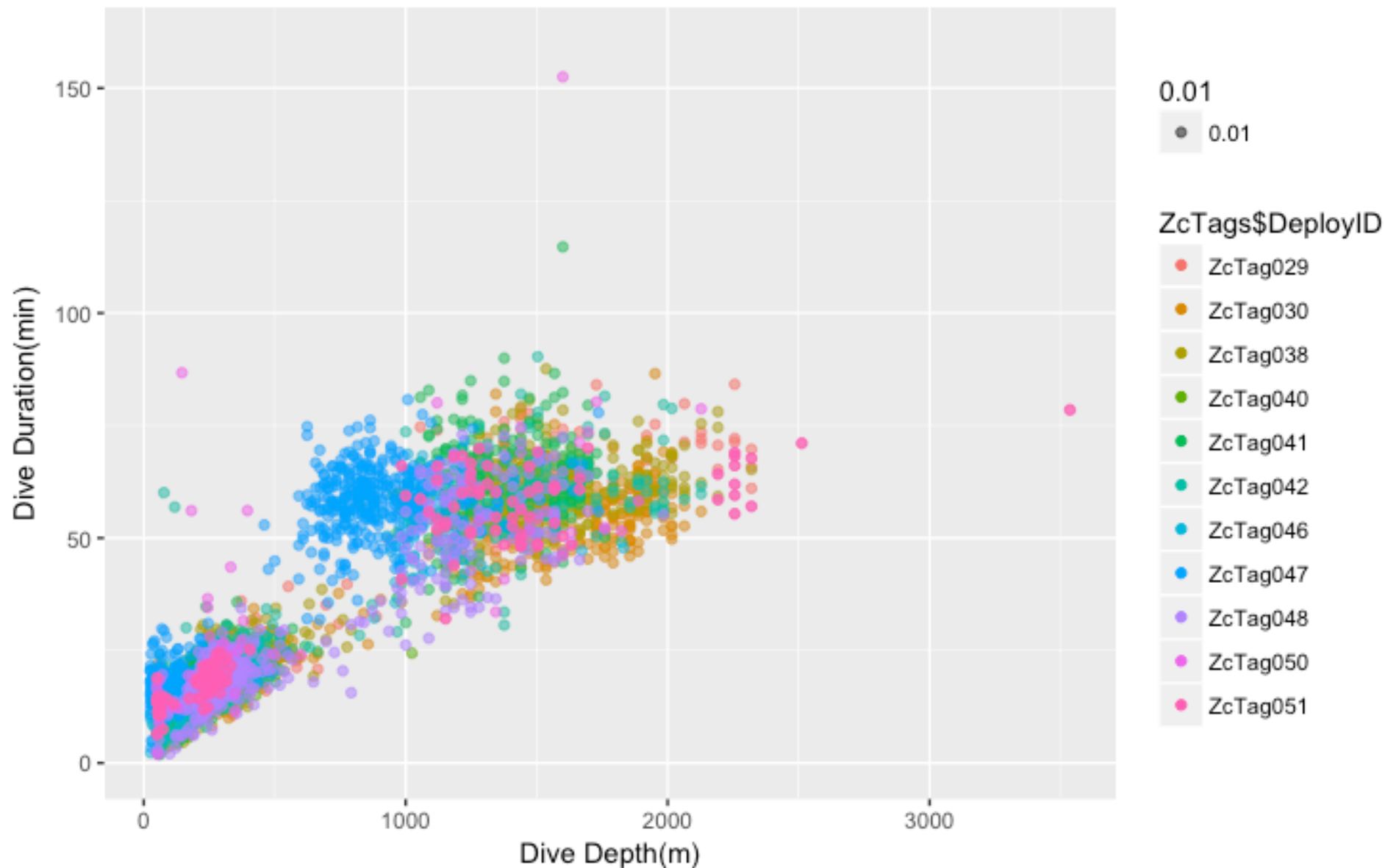
GmTag085 Depth Duration Distribution



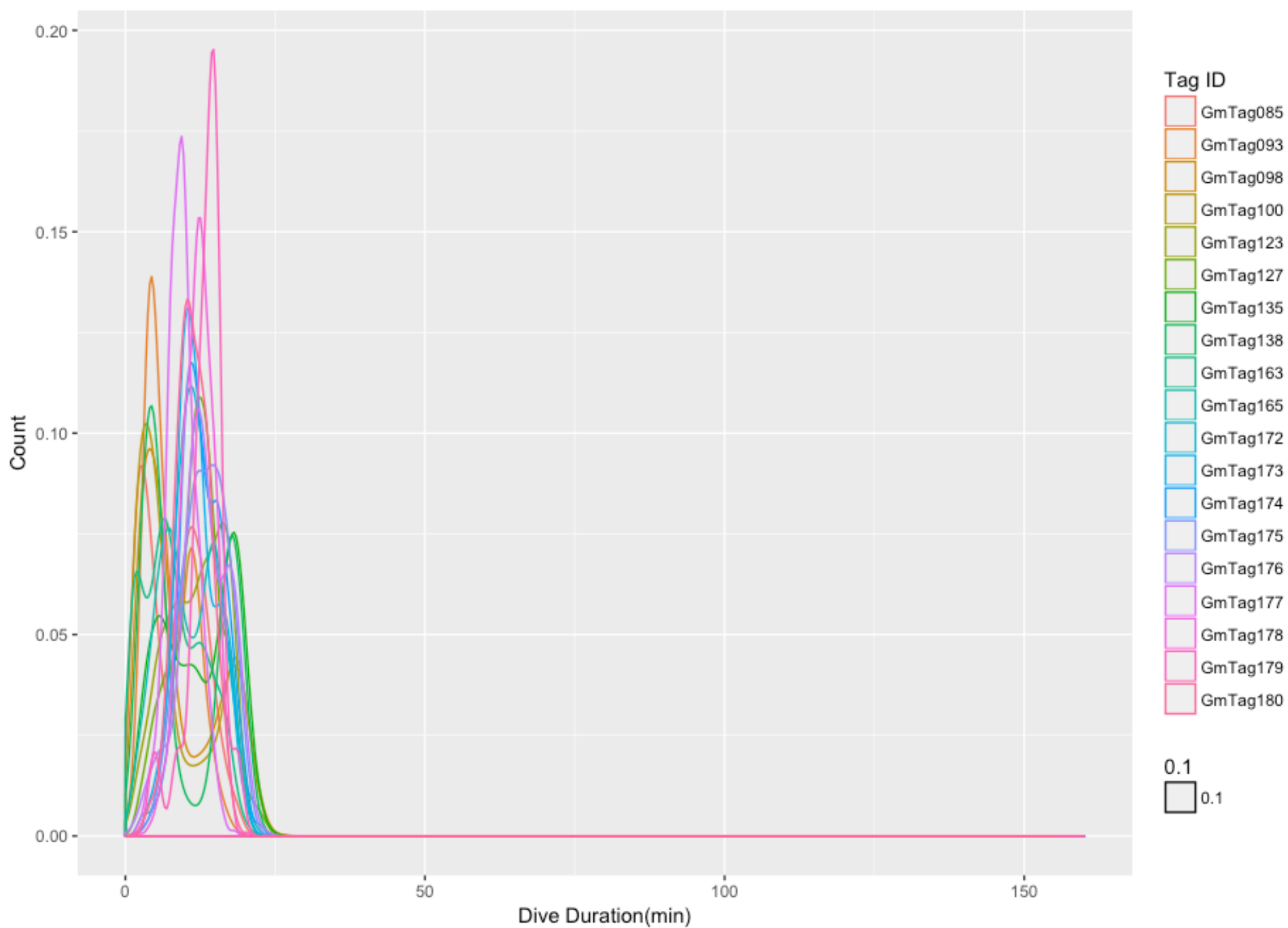
Pilot Whale Depth Duration Distribution



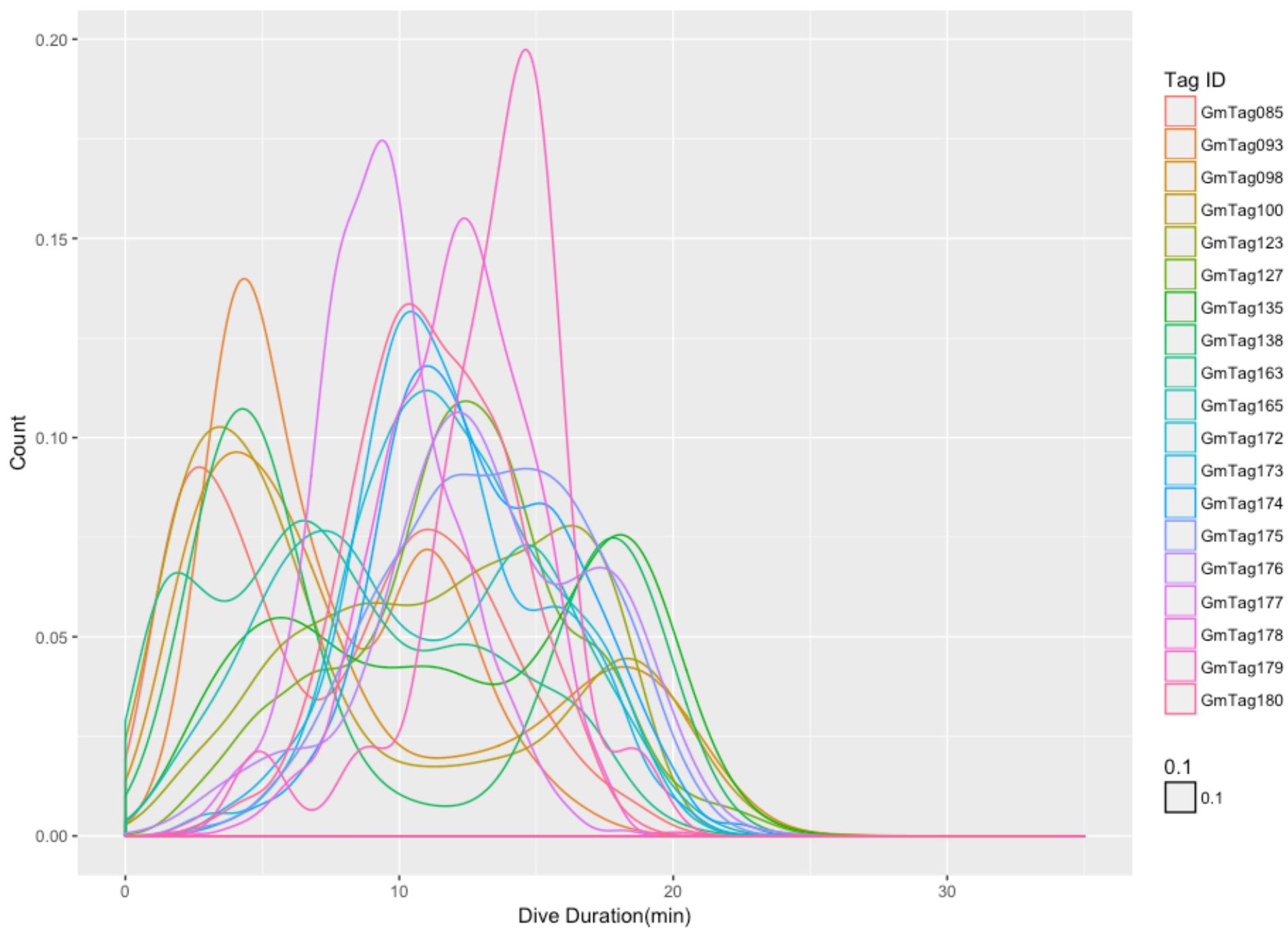
Beaked Whale Dive Depth Distribution



Pilot Whale Dive Duration Variation



Pilot Whale Dive Duration Variation



Questions?

