# diveMove dive threshold example

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## Introduction

A simple example demonstrating that single, shallow dives that cross the desired depth threshold (in the calibrateDepth function of diveMove) multiple times will be split into separate dives. We therefore recommend using a shallow dive threshold in calibrateDepth, followed by post hoc subsetting to retain deeper dives of interest.

```
# load packages
library(tidyverse)
library(diveMove)
library(here)

# set ggplot theme
gg_theme <- function () {
  theme_bw() %+replace%
    theme(
      axis.text = element_text(colour = "black", size = 11),
      axis.title = element_text(size=12),
      axis.ticks = element_line(colour = "black"),
      panel.grid = element_blank(),
      strip.background = element_blank(),
      panel.border = element_rect(colour = "black", fill = NA),
      axis.line = element_line(colour = "black"),
      legend.background = element_blank())
}
```

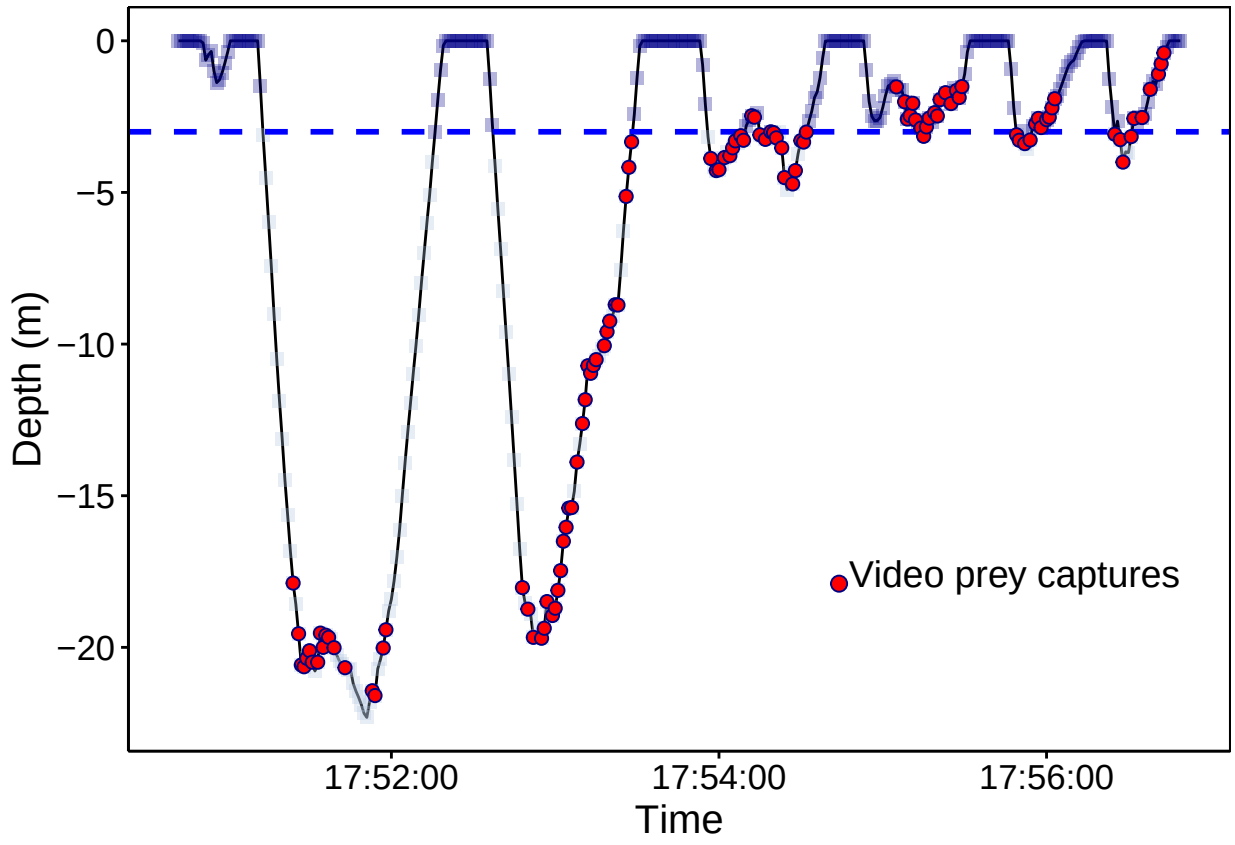
## Import TDR dive data (only a few dives)

```
dives <-  readRDS(here("data", "diveMove_threshold_example.rds"))

# Define colors for different dive phases (diveMove)
my_colors <- c("D" = "lightsteelblue",
               "DB" = "lightsteelblue",
               "B" = "lightsteelblue",
               "BA" = "lightsteelblue",
               "A" = "lightsteelblue",
               "DA" = "lightsteelblue",
               "X" = "darkblue")

# plot data
ggplot(data = dives,
       aes(x = date.time, y = depth*-1)) +
```

```
  geom_line() +
  geom_point(aes(colour = InDive), alpha = 0.3, size = 2, shape = 15)+
  scale_color_manual(values = my_colors)+
  scale_x_datetime(date_labels = "%H:%M:%S") +
  gg_theme() +
  xlab("Time") +
  ylab("Depth (m)")+
  geom_hline(yintercept = -3, color = "blue", linetype = "dashed", size = 1) +
  geom_point(data=subset(dives, PCE_1hz > 0),
             aes(x = date.time, y = depth*-1),
             fill = "red", col = "navy", shape = 21, size = 2) +
    annotate("text", x = max(dives$date.time),  y = -18, label = "Video prey captures",
           size = 5, color = "black", hjust = 1, vjust = 0)+
    annotate("point", x = max(dives$date.time)-125,  y = -17.9, size = 2.5,
             fill = "red", col = "navy", shape = 21)  +
  theme(legend.position = "none") +
  theme(axis.text = element_text(colour = "black", size = 13),
        axis.title = element_text(size=15))
```

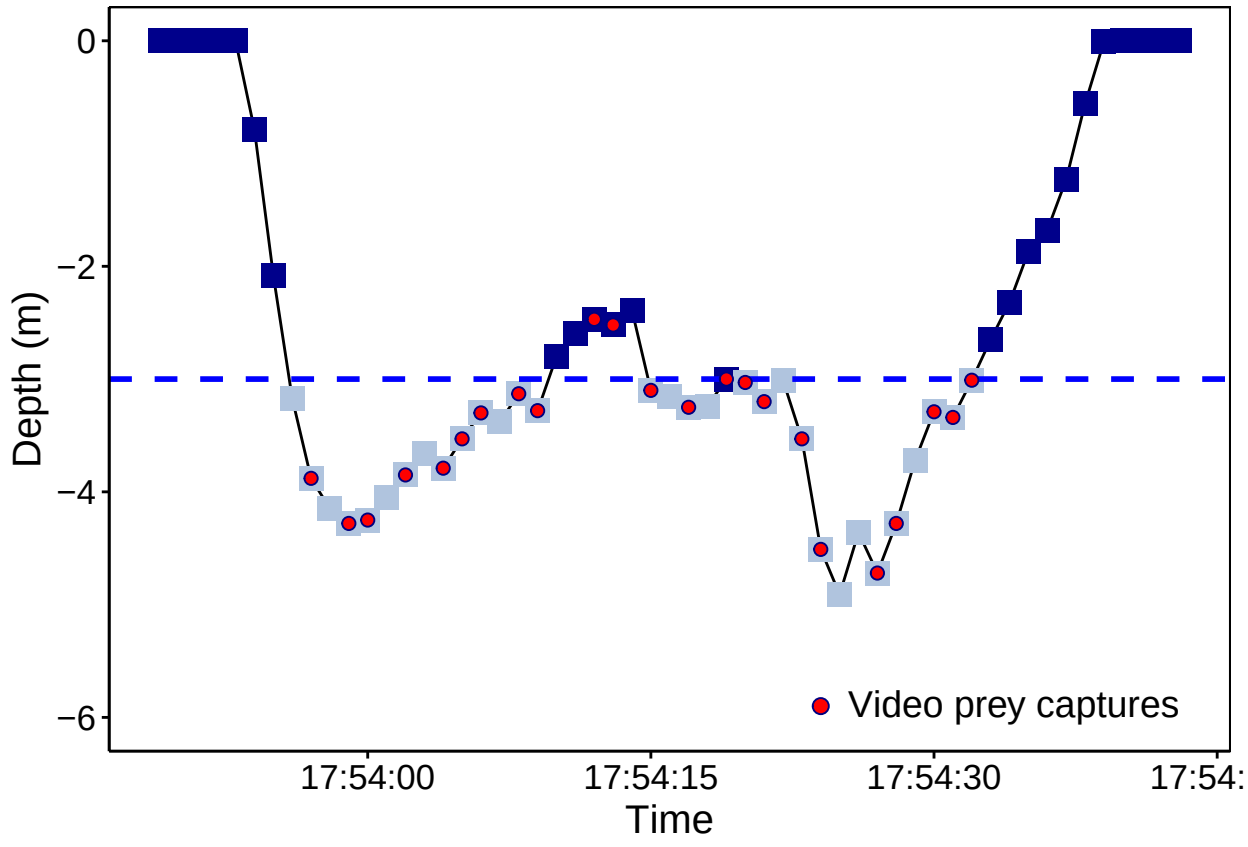



```
# Subset to only one dive

example_dive = dives %>%
  dplyr::filter(id == "2022_01_10_AC2101_DI02") %>%
  dplyr::filter(!is.na(vid_time)) %>%
  arrange(date.time) %>%
```

```
  dplyr::filter(date.time > '2022-01-10 17:53:48') %>%
  dplyr::filter(date.time < '2022-01-10 17:54:44')

# plot this one dive
ggplot(data = example_dive,
       aes(x = date.time, y = depth*-1)) +
  geom_line() +
  geom_point(aes(colour = InDive), alpha = 1, size = 4, shape = 15)+
  scale_color_manual(values = my_colors)+
  scale_x_datetime(date_labels = "%H:%M:%S") +
  gg_theme() +
  xlab("Time") +
  ylab("Depth (m)")+
  geom_hline(yintercept = -3, color = "blue", linetype = "dashed", size = 1) +
  geom_point(data=subset(example_dive, PCE_1hz > 0),
             aes(x = date.time, y = depth*-1),
             fill = "red", col = "navy", shape = 21, size = 2) +
  annotate("text", x = max(example_dive$date.time),  y = -6, label = "Video prey captures",
           size = 5, color = "black", hjust = 1, vjust = 0)+
   annotate("point", x = max(example_dive$date.time)-19,  y = -5.9, size = 2.5,
             fill = "red", col = "navy", shape = 21)  +
  theme(legend.position = "none") +
  theme(axis.text = element_text(colour = "black", size = 13),
        axis.title = element_text(size=15))
```



## 2. Divemove analysis with 3 m threshold

```
depth.threshold = 3

dat = as.data.frame(example_dive)

# now start creating the TDR dive object
filename = "Divedata"

tdr <- createTDR(time = dat$date.time,
                 depth = dat$depth,
                 speed = FALSE,
                 dtime = 1,   #  sampling interval used in seconds
                 file = filename)

# Don't do any zero-offset correction in this example (too little data)
tdr.calib = calibrateDepth(tdr,
                           dive.thr = depth.threshold, # only select dives deeper than threshold
                           zoc.method='offset',
                           offset = 0,
                           k=c(3, 5760),
                           probs=c(0.5, 0.02),
                           dive.model = "unimodal",
                           smooth.par=0.1,
                           knot.factor=20,
                           descent.crit.q=0.01,
                           ascent.crit.q=0,
                           na.rm=T)
```

```
## Record is truncated at the beginning and at the end
## 1 phases detected
```

```
## 3 dives detected
```

```
# diveMove detected 3 dives

# create dive summary metrics for each dive
dives <- diveStats(tdr.calib)
# list dives
dives
```

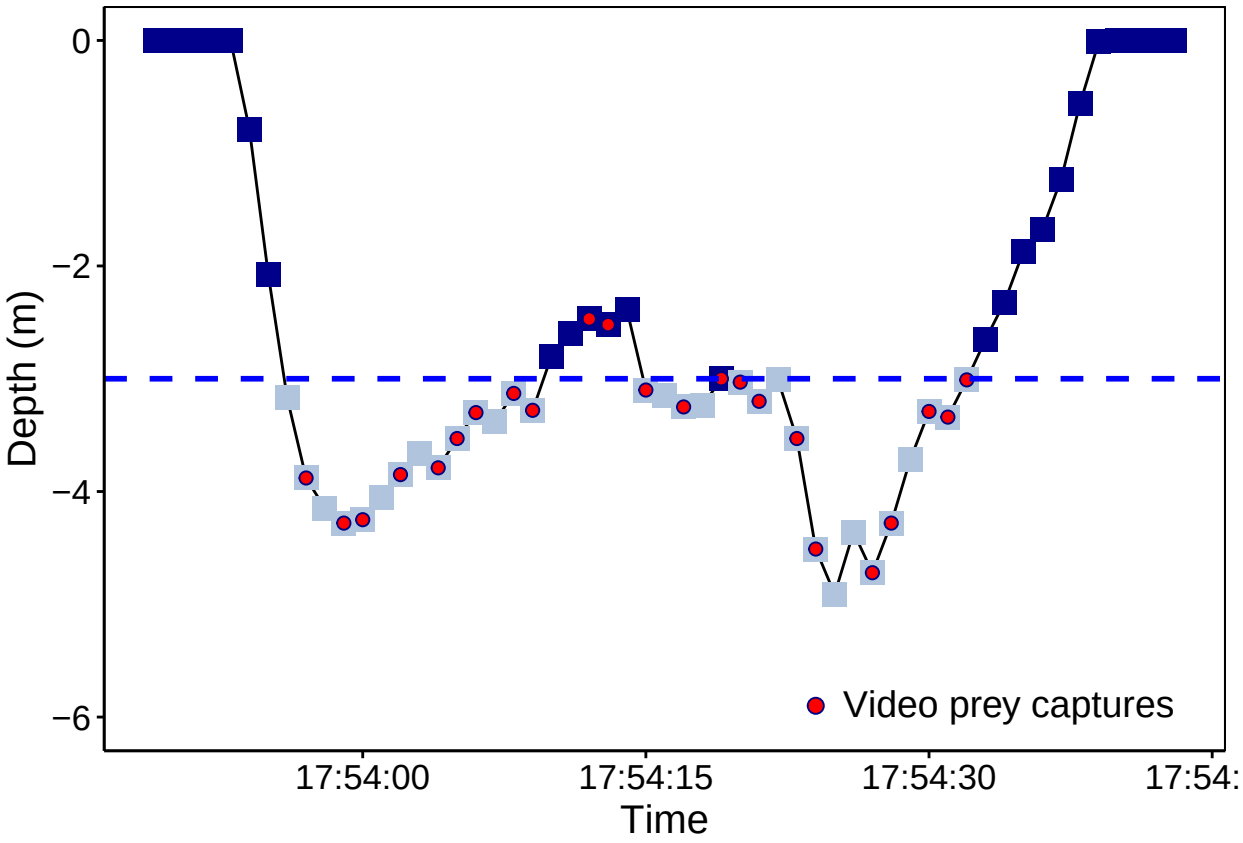
```
##               begdesc             enddesc              begasc desctim botttim
## 1 2022-01-10 17:53:56 2022-01-10 17:53:59 2022-01-10 17:53:59     3.5      NA
## 2 2022-01-10 17:54:15 2022-01-10 17:54:16 2022-01-10 17:54:18     1.5       2
## 3 2022-01-10 17:54:20 2022-01-10 17:54:26 2022-01-10 17:54:26     6.5      NA
##   asctim divetim descdist bottdist ascdist bottdep.mean bottdep.median
## 1   10.5      14     4.28       NA    4.28           NA             NA
## 2    0.5       4     3.15     0.11    3.24     3.213333           3.24
## 3    6.5      13     4.91       NA    4.72           NA             NA
##   bottdep.sd maxdep postdive.dur   descD.min descD.1stqu descD.median
## 1         NA   4.28            4 -0.04293979   0.2738207    0.8674901
## 2 0.05507571   3.25            0  0.03105096   0.3935254    1.4913594
```

```
## 3         NA   4.91           10 -0.01213130   0.2862383    0.4754847
##   descD.mean descD.3rdqu descD.max  descD.sd  bottD.min bottD.1stqu
## 1  0.8340047   1.3880909  1.654274 0.5785022         NA          NA
## 2  1.5254468   2.6369375  3.111415 1.1240603 -0.7622003           0
## 3  0.5393482   0.7871641  1.178591 0.3378142         NA          NA
##   bottD.median  bottD.mean bottD.3rdqu  bottD.max  bottD.sd  ascD.min
## 1           NA         NaN          NA         NA        NA -1.239714
## 2            0 -0.05178154           0 0.02291055 0.1576359 -3.870858
## 3           NA         NaN          NA         NA        NA -1.235706
##   ascD.1stqu ascD.median  ascD.mean  ascD.3rdqu    ascD.max   ascD.sd
## 1 -0.5496406  -0.1359974 -0.3536900 -0.09538822 -0.04786388 0.3826025
## 2 -3.6081813  -3.0467581 -2.8127793 -2.15812501 -0.95316894 0.9222441
## 3 -0.8117721  -0.4246097 -0.5334972 -0.24954028 -0.01962847 0.3601750
```

```
# plot the dive classification
# plotTDR(tdr.calib, surface=TRUE)

#  recreate this above plot manually
dat$InDive = tdr.calib@dive.phases

ggplot(data = dat,
         aes(x = date.time, y = depth*-1)) +
  geom_line() +
  geom_point(aes(colour = InDive), alpha = 1, size = 4, shape = 15)+
  scale_color_manual(values = my_colors)+
  scale_x_datetime(date_labels = "%H:%M:%S") +
  geom_point(data=subset(example_dive, PCE_1hz > 0),
             aes(x = date.time, y = depth*-1),
             fill = "red", col = "navy", shape = 21, size = 2) +
  gg_theme() +
  xlab("Time") +
  ylab("Depth (m)")+
  geom_hline(yintercept = -3, color = "blue", linetype = "dashed", size = 1) +
  annotate("text", x = max(example_dive$date.time),  y = -6, label = "Video prey captures",
           size = 5, color = "black", hjust = 1, vjust = 0)+
   annotate("point", x = max(example_dive$date.time)-19,  y = -5.9, size = 2.5,
             fill = "red", col = "navy", shape = 21)  +
  theme(legend.position = "none") +
  theme(axis.text = element_text(colour = "black", size = 13),
        axis.title = element_text(size=15))
```




The dark blue squares in the plot above represent data points that are shallower than 3 m depth. Light grey squares are data points deeper than 3 m depth. Note that the diveMove "threshold" (blue dashed line) does not exclude entire "dives" below the 3 m threshold, but ALL depth values $< 3$ m (i.e., all dark blue squares). Here, the result is that a single shallow dive crossing the 3 m threshold several times is divided into 3 individual dives (a dive ends each time the light grey squares transition to dark squares).

To prevent shallow dives that cross the desired depth threshold multiple times from being split into separate dives, one can specify a shallow dive depth in diveMove's calibrateDepth function. Subsequently, dives can be subset based on a greater (desired) maximum dive depth.

## 2. Divemove analysis with 0.4 m threshold

```
depth.threshold = 0.4

dat = as.data.frame(example_dive)

# now start creating the TDR dive object
filename = "Divedata"

tdr <- createTDR(time = dat$date.time,
                 depth = dat$depth,
                 speed = FALSE,
                 dtime = 1,   #  sampling interval used in seconds
                 file = filename)
```

```
# Don't do any zero-offset correction
tdr.calib = calibrateDepth(tdr,
                           dive.thr = depth.threshold, # only select dives deeper than threshold
                           zoc.method='offset',
                           offset = 0,
                           k=c(3, 5760),
                           probs=c(0.5, 0.02),
                           dive.model = "unimodal",
                           smooth.par=0.1,
                           knot.factor=20,
                           descent.crit.q=0.01,
                           ascent.crit.q=0,
                           na.rm=T)
```

```
## Record is truncated at the beginning and at the end
## 1 phases detected

## 1 dives detected
```

```
# divemove detect 1 dive.

# create dive summary metrics for each dive
dives <- diveStats(tdr.calib)

# list dives
dives
```

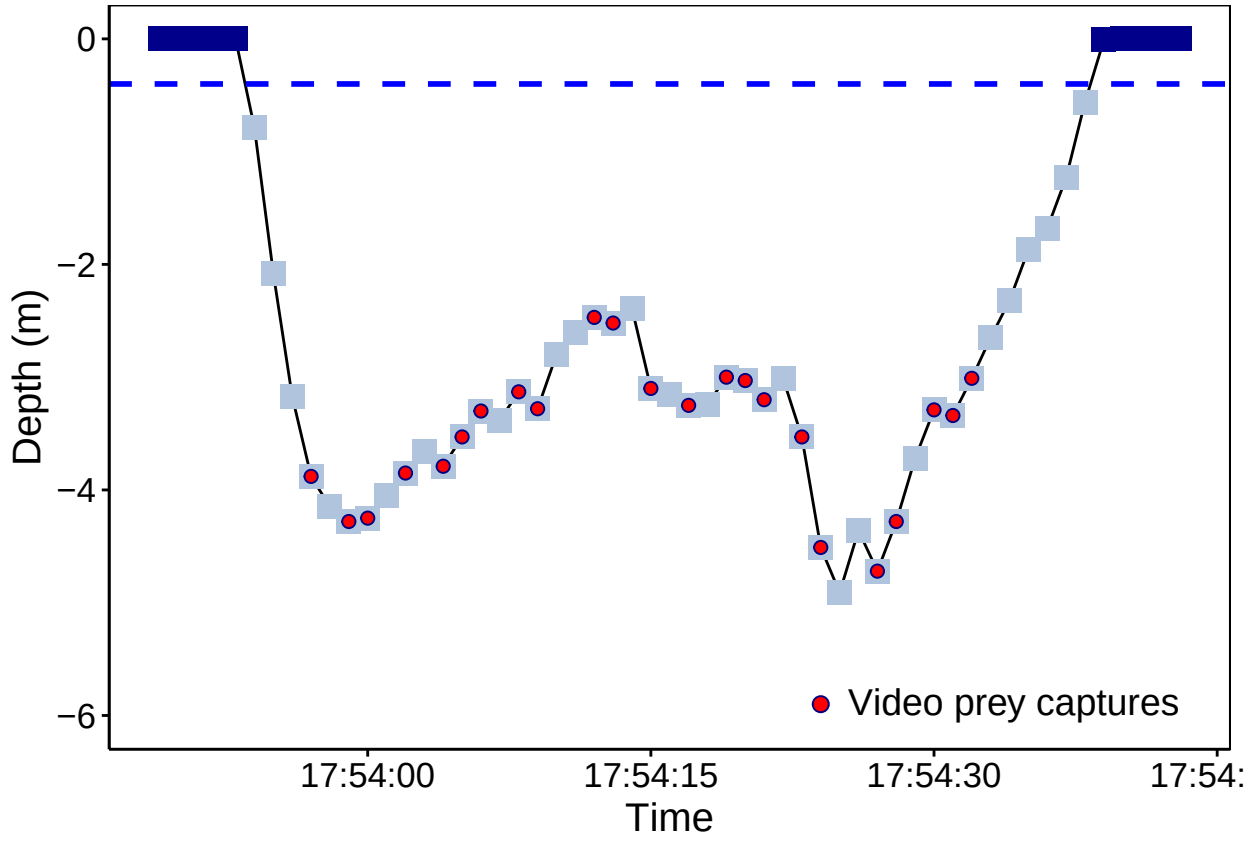
```
##               begdesc             enddesc              begasc desctim botttim
## 1 2022-01-10 17:53:54 2022-01-10 17:54:00 2022-01-10 17:54:26     6.5      26
##   asctim divetim descdist bottdist ascdist bottdep.mean bottdep.median
## 1   12.5      45     4.28     6.63    4.72     3.381111           3.25
##   bottdep.sd maxdep postdive.dur    descD.min descD.1stqu descD.median
## 1   0.634637   4.91            4 0.0003386873  0.08086243    0.4145446
##   descD.mean descD.3rdqu descD.max  descD.sd bottD.min  bottD.1stqu
## 1  0.4370269   0.7878064 0.9326738 0.3439157         0 5.726378e-18
##   bottD.median bottD.mean bottD.3rdqu bottD.max   bottD.sd   ascD.min
## 1 1.879545e-16  0.0427699  0.01725301 0.2876817 0.08649435 -0.5110617
##   ascD.1stqu ascD.median ascD.mean ascD.3rdqu   ascD.max   ascD.sd
## 1 -0.4152066  -0.3258125 -0.333679 -0.3077708 0.01516299 0.1172961
```

```
# plot the dive classification
# plotTDR(tdr.calib, surface=TRUE)

#  recreate this plot manually
dat$InDive = tdr.calib@dive.phases


ggplot(data = dat,
       aes(x = date.time, y = depth*-1)) +
  geom_line() +
  geom_point(aes(colour = InDive), alpha = 1, size = 4, shape = 15)+
  scale_color_manual(values = my_colors)+
```

```
  scale_x_datetime(date_labels = "%H:%M:%S") +
  geom_point(data=subset(example_dive, PCE_1hz > 0),
             aes(x = date.time, y = depth*-1),
             fill = "red", col = "navy", shape = 21, size = 2) +
  gg_theme() +
  xlab("Time") +
  ylab("Depth (m)")+
  geom_hline(yintercept = -0.4, color = "blue", linetype = "dashed", size = 1) +
  annotate("text", x = max(example_dive$date.time),  y = -6, label = "Video prey captures",
           size = 5, color = "black", hjust = 1, vjust = 0)+
   annotate("point", x = max(example_dive$date.time)-19,  y = -5.9, size = 2.5,
             fill = "red", col = "navy", shape = 21)  +
  theme(legend.position = "none") +
  theme(axis.text = element_text(colour = "black", size = 13),
        axis.title = element_text(size=15))
```




```
# It is likely that one may not want to analyse all the dives with a shallow maximum dive depth.
# Dives with a maximum depth shallower than 3 m can then be filtered out of the dive summary.

dives <- dives[dives$maxdep >= 3, ]
```