Load packages

```
library('car')
library('lsmeans')
library('plyr')
library('dplyr')
library('ggplot2')
library('knitr')
library('scales')
```

Define some helper functions

```
get_means <- function(x){
  list(means = as.data.frame(summary(x[[1]])),
       diffs = as.data.frame(summary(x[[2]]))
  )
}

gg <- function(){
  list(
    geom_point(size = 4),
    geom_errorbar(limits, size = 1, width=0.2),
    theme_grey(base_size = 18)
  )
}

limits <- aes(ymax = lsmean + SE, ymin = lsmean - SE)

# Define function to get quick summary by factor variable
avg_by <- function(...){
  dat_df %>%
    group_by(...) %>%
    summarise(rdm_mean = mean(rdm, na.rm = TRUE),
              rdm_sd = sd(rdm, na.rm = TRUE),
              rdm_n = length(na.omit(rdm))) %>%
    kable(format = "markdown")
}
```

Summary of data

Prep data

```
dat <- read.csv("dittes_data2.csv", stringsAsFactors = FALSE)
dat$date <- as.Date(paste(as.character(dat$year), "-01-01", sep = ""), "%Y-%m-%d")
dat <- dat[ !dat$habitat == 2, ] # drop habitat=32
dat$rdm <- dat$rdm*100 # multiply rdm by 100
dat$landform <- tolower(dat$landform)
```

Make a `dplyr` `tbl_df` object

```
dat_df <- tbl_df(dat)
```

by transect

```
avg_by(transect)
```

transect	rdm_mean	rdm_sd	rdm_n
AD10	1346.4	1142.5	84
AD11	1847.6	1803.2	85
AD12	1789.4	1287.7	85
AL1	941.9	707.2	80
BK5	840.0	688.7	70
BL7	1677.6	1663.6	85
ML9	1567.6	1913.6	85
NF6	1146.7	802.3	75
NV8	1246.1	1159.9	85
PK2	1069.3	677.5	75
PL3	725.5	686.4	85
PL4	751.8	503.1	85

by year

```
avg_by(year)
```

year	rdm_mean	rdm_sd	rdm_n
1997	1721.7	2574.7	60
1998	1887.5	1839.5	60
1999	2024.0	1920.7	50
2000	1267.6	1033.7	110
2001	1521.7	947.3	120
2002	1055.8	769.4	120
2003	727.7	407.7	110
2004	887.1	532.1	120
2005	1711.8	1326.1	110
2014	745.0	625.3	119

by soil type

```
avg_by(soil)
```

soil	rdm_mean	rdm_sd	rdm_n
Kc	1069.3	677.5	75
SuD	1683.7	1317.0	46
TfD	1325.6	967.8	41
TgD	1472.5	1646.9	257
TgE	2160.0	1499.4	30
ThE	1526.8	1351.1	200

soil	rdm_mean	rdm_sd	rdm_n
ToE	965.0	386.6	10
TuB	768.2	627.5	240
Txc	941.9	707.2	80

by slope_class

```
avg_by(slope_class)
```

slope_class	rdm_mean	rdm_sd	rdm_n
1	1134.1	1281.9	523
2	1275.2	1055.5	204
3	1529.6	1324.0	240
4	795.8	628.3	12

by landform

```
avg_by(landform)
```

landform	rdm_mean	rdm_sd	rdm_n
foothills	1524.0	1469.2	584
terraces	860.6	663.4	395

by habitat

```
avg_by(habitat)
```

habitat	rdm_mean	rdm_sd	rdm_n
grassland	1156	1123	700
woodland	1508	1505	279

All combinations of variables

```
avg_by(transect, year, soil, slope_class, landform, habitat) %>% data.frame
```

Data analysis

All analyses are done with `rdm` (residual dry matter in lbs/sq acre) as the response variable. Plots use least square means for the y-variables since these take into account the statistical model that was used, wehreas raw data, although more meaningful, may be misleading. Confidence intervals on plots are 95% CI's.

Prepare data a bit

```
dat <- dat_df %>% filter(!is.na(rdm), !rdm < 2) %>% mutate(soil = as.factor(soil))
```

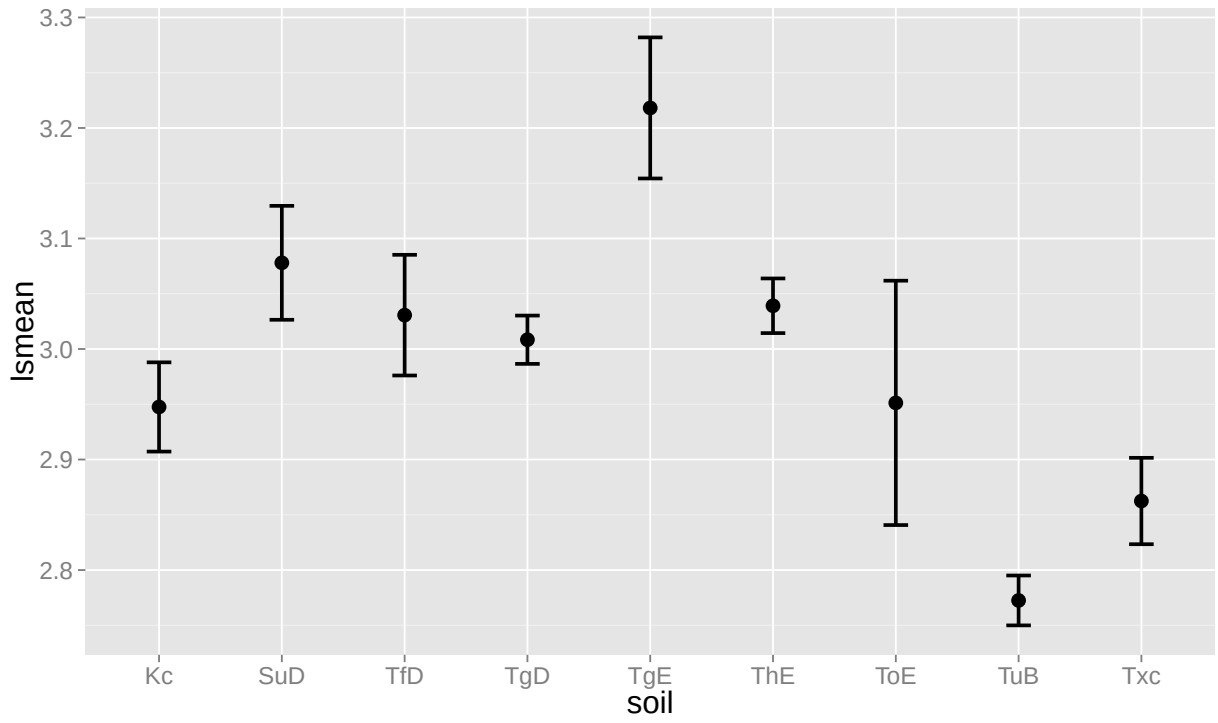
Does RDM differ between soil types?

```
mod <- dat %>% lm(log10(rdm + 1) ~ soil, data=.)
# mod %>% plot
mns <- mod %>% lsmeans(list(pairwise ~ soil), adjust = c("tukey")) %>% get_means
mod %>% Anova(type = "3") %>% kable(format = "markdown")
```

	Sum Sq	Df	F value	Pr(>F)
(Intercept)	651.61	1	5331.46	0
soil	13.81	8	14.13	0
Residuals	118.43	969	NA	NA

Plot by soil type

```
mns$means %>% ggplot(aes(soil, lsmean)) + gg()
```



Does RDM differ among years within each transect?

```
mods <- dat %>% mutate(year = as.factor(year)) %>% group_by(transect) %>% do(model = lm(log10(rdm + 1)
# mods$model[[1]] %>% plot
mns_s <- lapply(mods$model, function(x) x %>% lsmeans(list(pairwise ~ year), adjust = c("tukey")) %>% g
for(i in seq_along(mods$model)){
  cat("\n")
  cat(sprintf("__%s__\n", mods$transect[i]))
  mods$model[[i]] %>% Anova(type = "3") %>% kable(format = "markdown")
}
```

AD10

	Sum Sq	Df	F value	Pr(>F)
(Intercept)	45.617	1	329.698	0.0000
year	3.037	9	2.439	0.0173
Residuals	10.239	74	NA	NA

AD11

	Sum Sq	Df	F value	Pr(>F)
(Intercept)	60.764	1	993.08	0
year	7.633	9	13.86	0
Residuals	4.528	74	NA	NA

AD12

	Sum Sq	Df	F value	Pr(>F)
(Intercept)	54.329	1	603.86	0.0000
year	2.453	9	3.03	0.0039
Residuals	6.748	75	NA	NA

AL1

	Sum Sq	Df	F value	Pr(>F)
(Intercept)	36.862	1	482.820	0e+00
year	2.983	8	4.885	1e-04
Residuals	5.421	71	NA	NA

BK5

	Sum Sq	Df	F value	Pr(>F)
(Intercept)	34.209	1	382.069	0
year	4.491	7	7.165	0
Residuals	5.551	62	NA	NA

BL7

	Sum Sq	Df	F value	Pr(>F)
(Intercept)	44.255	1	424.949	0.0000
year	2.921	9	3.116	0.0031
Residuals	7.811	75	NA	NA

ML9

	Sum Sq	Df	F value	Pr(>F)
(Intercept)	58.661	1	772.27	0e+00
year	3.247	9	4.75	1e-04
Residuals	5.697	75	NA	NA

NF6

	Sum Sq	Df	F value	Pr(>F)
(Intercept)	43.382	1	548.19	0e+00
year	2.735	8	4.32	3e-04
Residuals	5.223	66	NA	NA

NV8

	Sum Sq	Df	F value	Pr(>F)
(Intercept)	32.461	1	197.346	0.0000
year	2.758	9	1.863	0.0707
Residuals	12.337	75	NA	NA

PK2

	Sum Sq	Df	F value	Pr(>F)
(Intercept)	39.061	1	819.681	0
year	2.405	8	6.307	0
Residuals	3.145	66	NA	NA

PL3

	Sum Sq	Df	F value	Pr(>F)
(Intercept)	32.955	1	500.171	0
year	3.290	9	5.548	0
Residuals	4.942	75	NA	NA

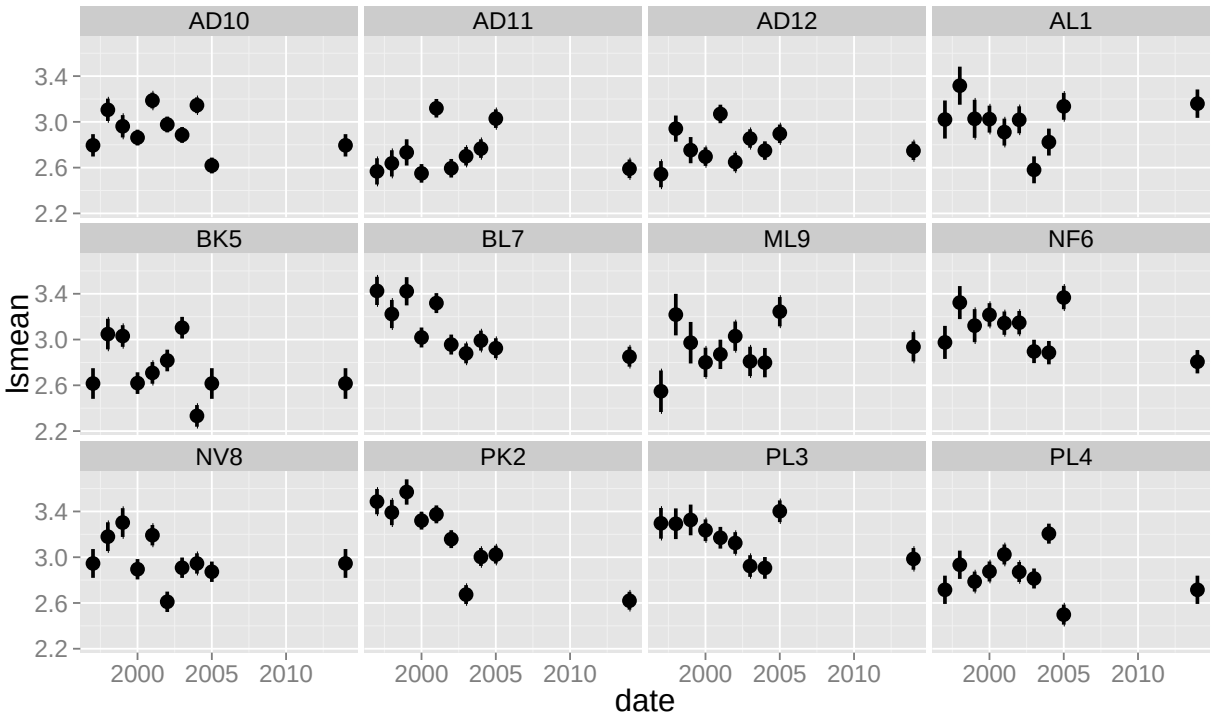
PL4

	Sum Sq	Df	F value	Pr(>F)
(Intercept)	32.328	1	494.225	0.0000

	Sum Sq	Df	F value	Pr(>F)
year	1.676	9	2.847	0.0061
Residuals	4.906	75	NA	NA

Plot for each transect, among years

```
rbind_all(Map(function(x,y) data.frame(transect=y, x), lapply(mns_s, "[[", "means"), unique(dat_df$trans
  mutate(date = as.Date(paste0(year,"-01-01"), "%Y-%m-%d")) %>%
  ggplot(aes(date, lsmean)) + gg() + facet_wrap(~ transect) + scale_x_date(labels = date_format("%Y"))
```



Power analysis (to figure out appropriate sample size)

NOT DONE YET...