



STUDY ON THE PHENOLOGY OF ASPEN

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Aspen (*Populus tremuloides*)

- Keystone species in many North American ecosystems
 - Support biodiversity
 - Provide numerous ecosystem amenities
- SAD – Sudden Aspen Decline
 - Affecting approximately 100,000 hectares of land
 - Disease, insect, fungi proliferation, severe drought, environmental change



ASPEN THROUGH THE SEASONS

- Deciduous species



<http://www.fs.usda.gov/>

- Chlorophyll- Green
- Xanthophylls – yellow
- Carotenoids- orange
- Anthocyanins- reds
- Tannins- brown

<http://www.na.fs.fed.us/fhp/pubs/leaves/leaves.shtm>

PHENOLOGY

- Phenology is the study of the timing of biological or life cycle events in plants and animals
 - Aspen phenology
 - Elevation
 - Precipitation



MONITORING PHENOLOGY

- On the ground

- Inefficient
- Time-consuming
- Requires a lot of people which can inflate cost

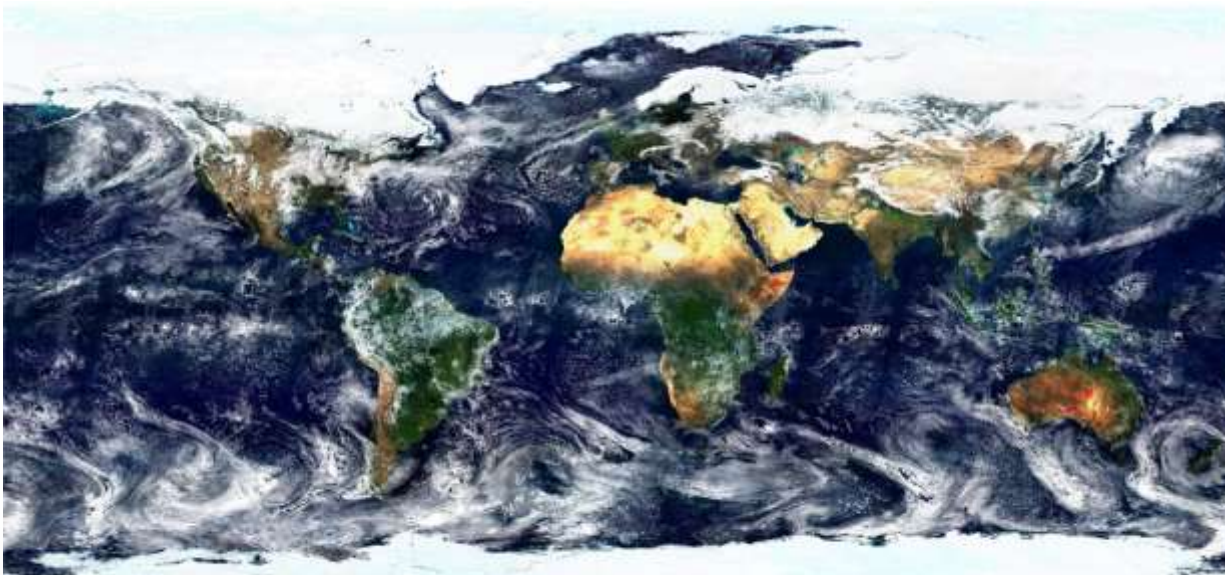


- Remote Sensing

- Study of obtaining information about objects or areas from a distance, either by aircrafts or satellites.
- Very efficient
- Allows you to cover a large area in a short amount of time
- Does not require a lot of people to perform
- Can be very cost effective

METHODS - MODIS

- MODIS
 - Moderate Resolution Imaging Spectrometer
 - Terra satellite
- Obtained 8-day MODIS composites from WyomingView for years 2002 (drought), 2006 (wet) and 2010 (normal)
 - 46 images/year



METHODS – NDVI

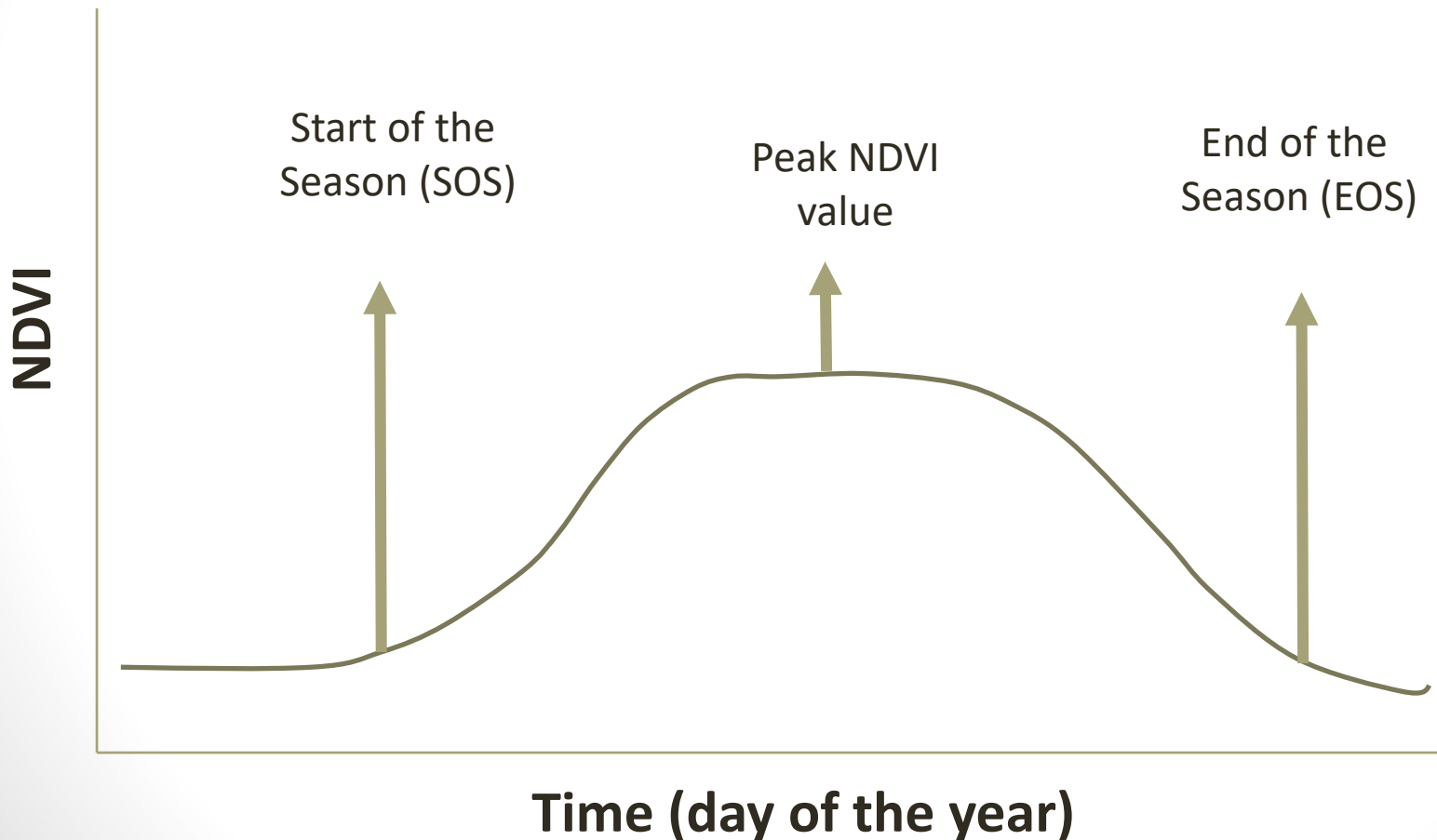
- Extracted band 1 (red) and band 2 (near infrared) values from each image
 - Computed NDVI (Normalized Difference Vegetation Index)

$$\text{NDVI} = \frac{(\text{NIR} - \text{Red})}{(\text{NIR} + \text{Red})}$$

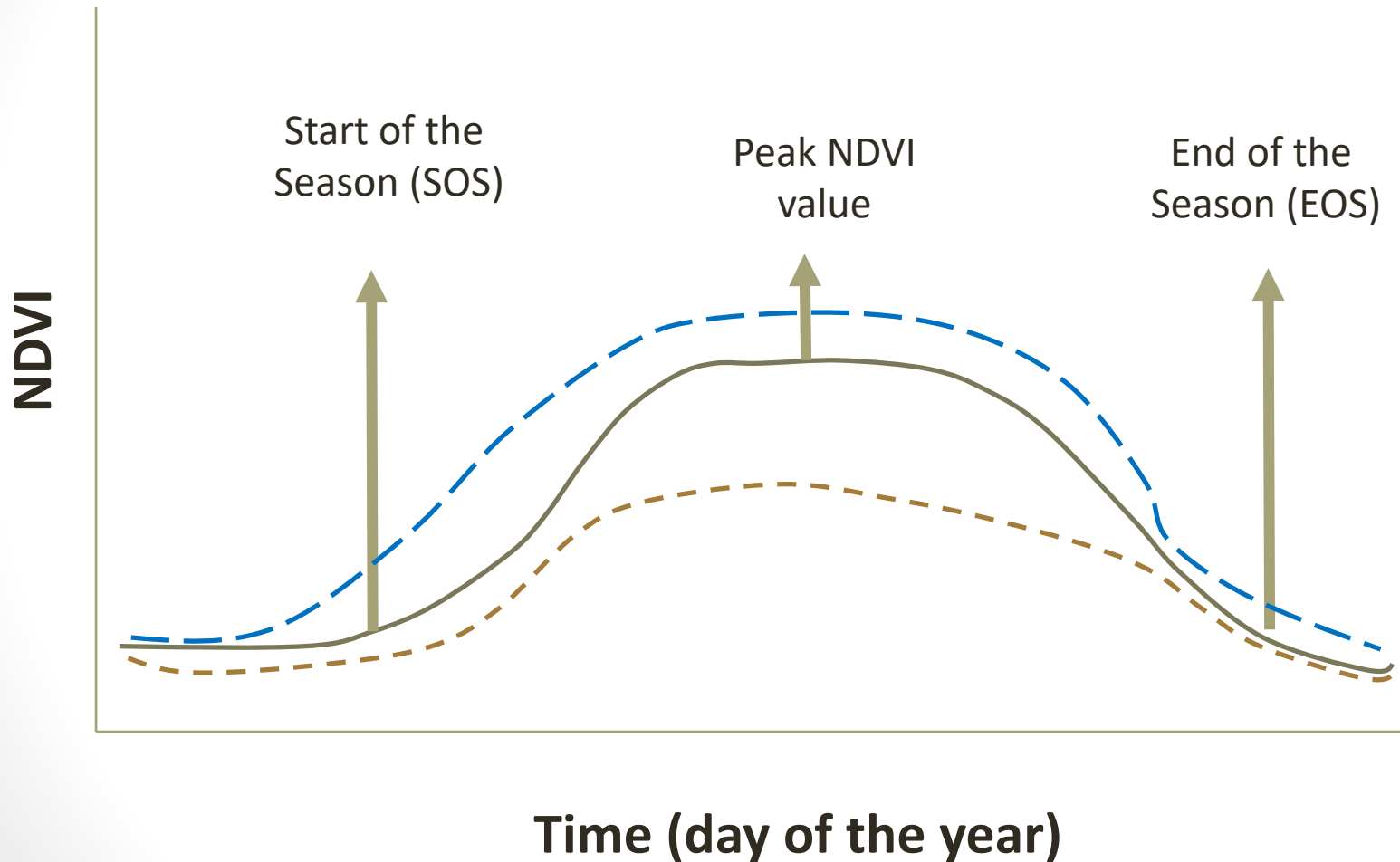
Calculating NDVI enabled us to compare and draw conclusions from the differences in plant reflectance.

METHODS – OUTLIERS & PLOTS

- Plotted NDVI values (y axis) against time (x axis)
- Removed outliers

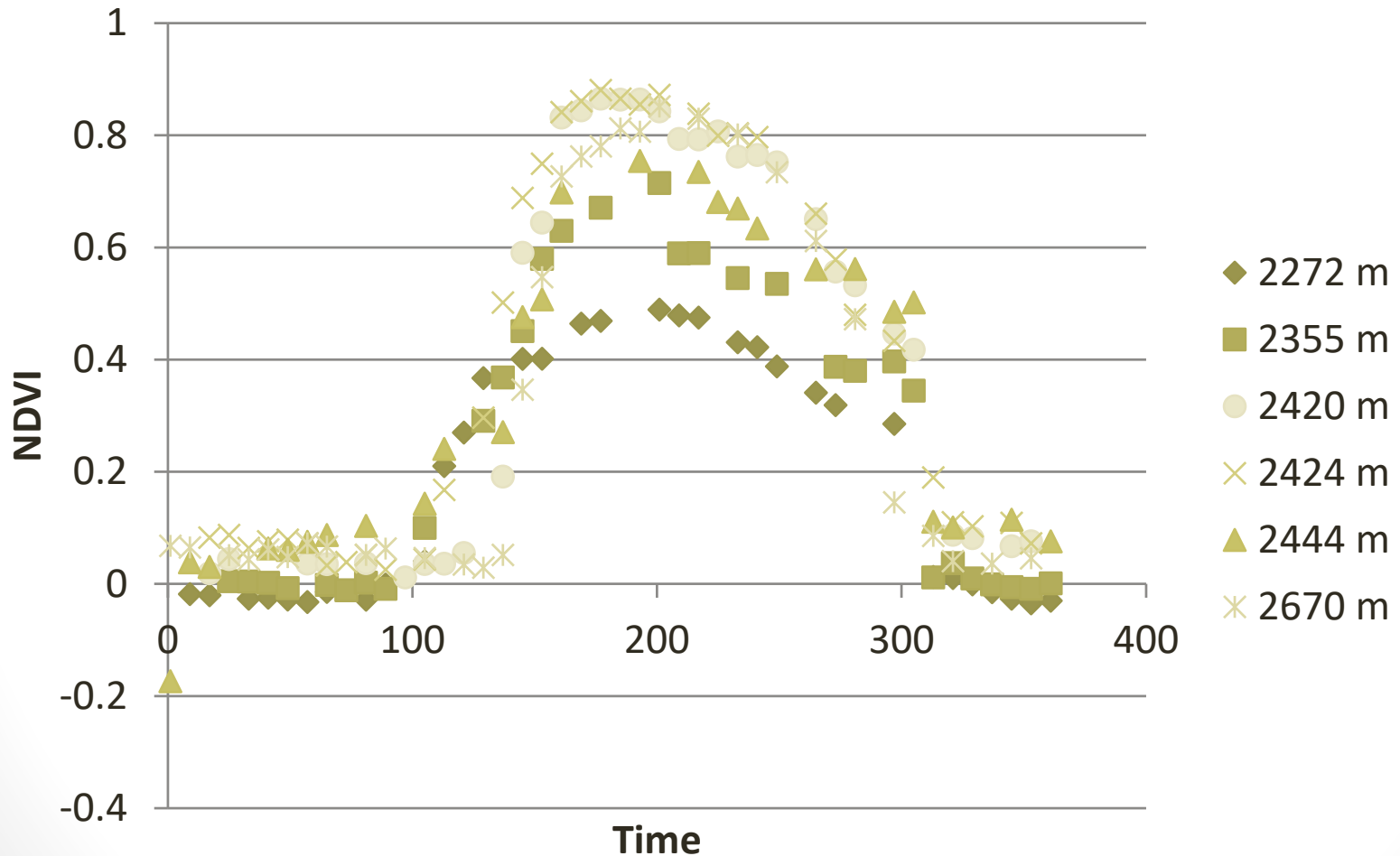


METHODS - HYPOTHESIS



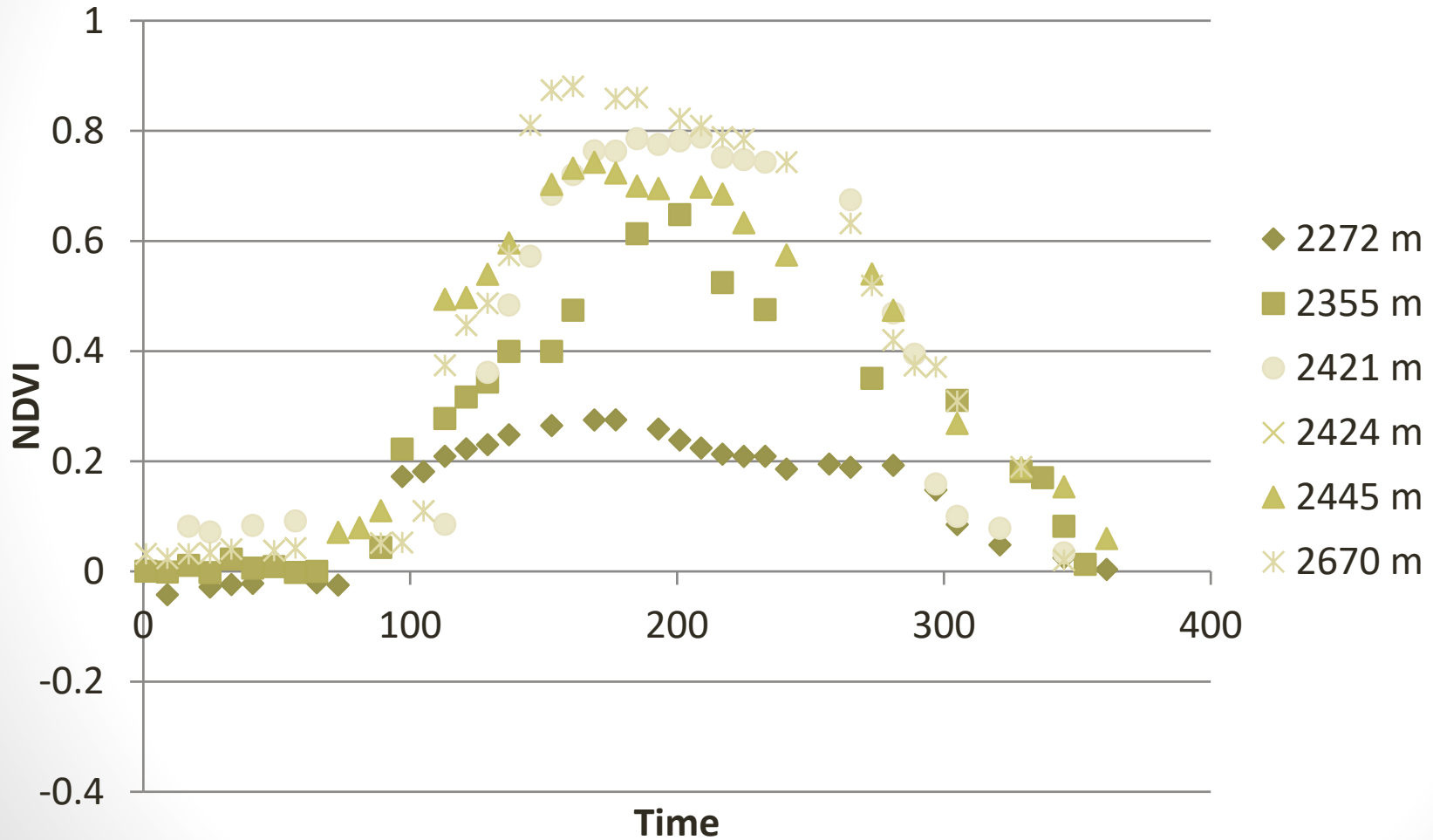
RESULTS

2010 - NORMAL YEAR



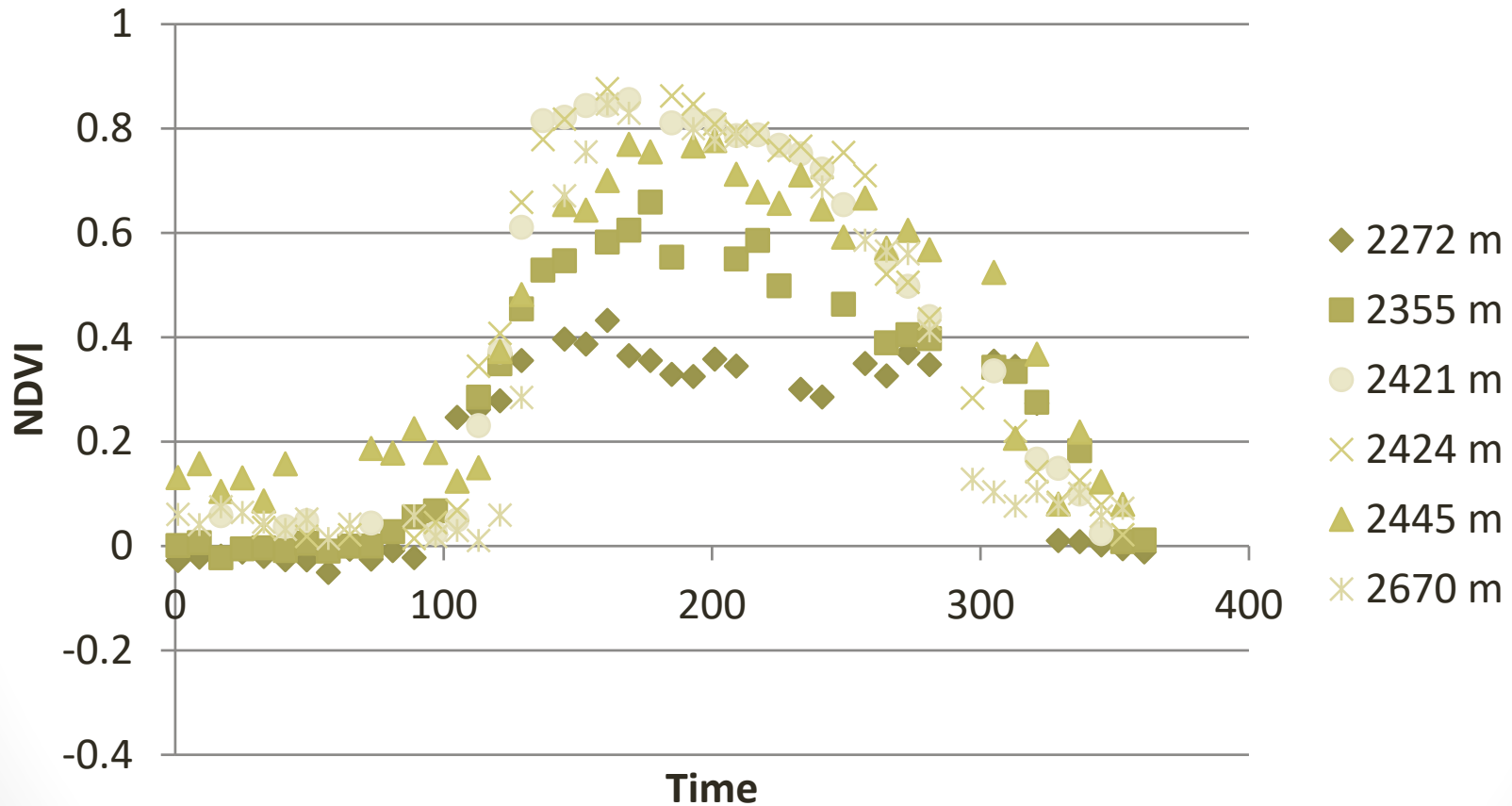
RESULTS

2002 – DROUGHT YEAR



RESULTS

2006 – WET YEAR



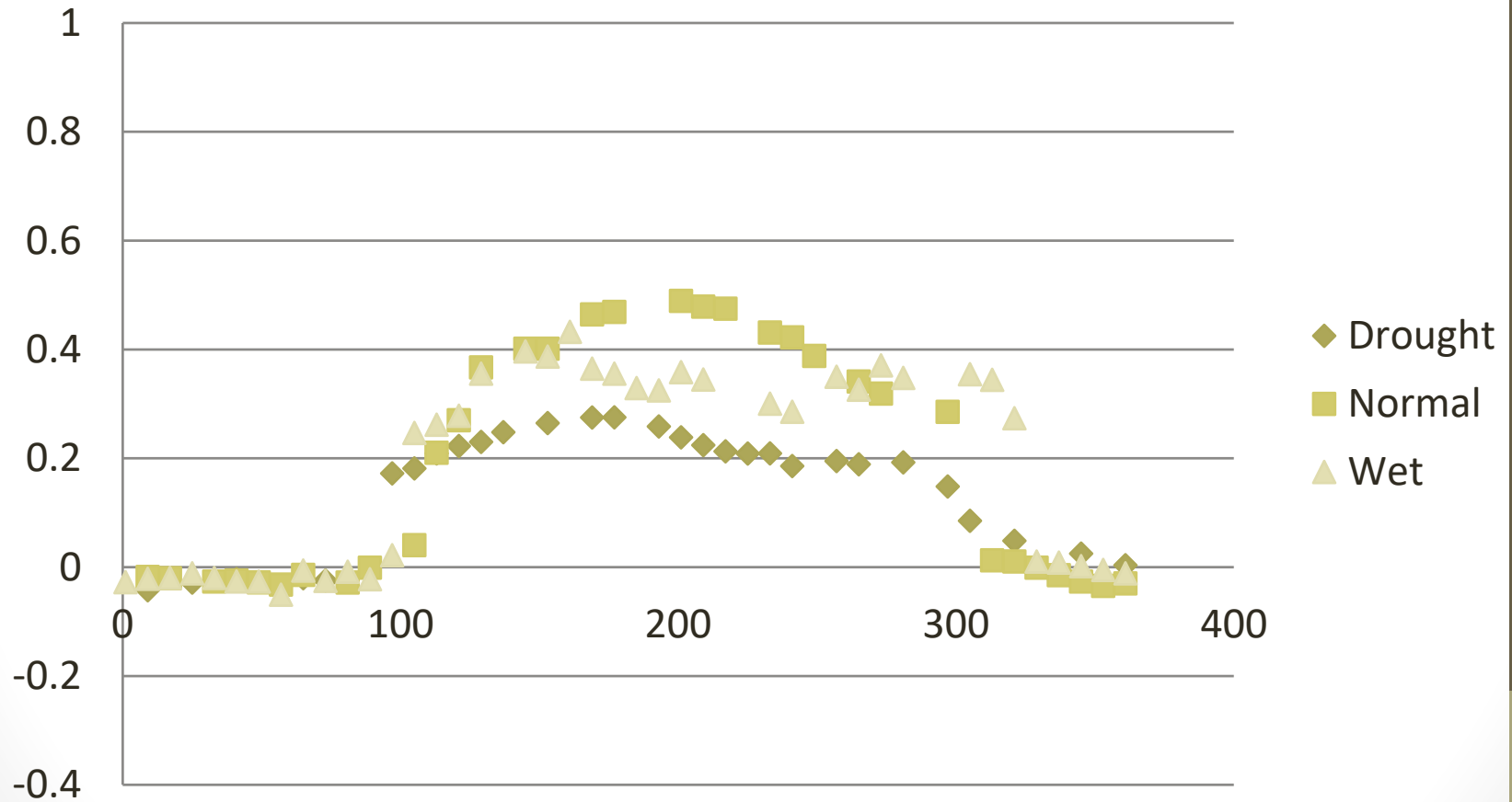
RESULTS - ELEVATION

- Peak NDVI value
 - Stands growing at lower elevations (2272m & 2355m) had the lowest peak NDVI values in normal, drought, and wet years
 - Remaining four stands (> 2420m) had higher peak NDVI values and were all similar
- Start of the season
 - Stand growing at highest elevation (2670m) showed delayed start in normal, drought and wet years
 - Stand growing at 2421 m had a delayed start in normal and drought years – field work is required to ascertain the growing conditions of this stand (shading effect)

RESULTS - PRECIPITATION

- Stand growing at lowest elevation
 - Peak NDVI value was lowest in drought year (2002)
 - However, the peak NDVI value was lower in the wet year (2006) in comparison to the normal year (2010)
 - Unexpected result
 - Field verification is necessary
- Similar results were noticed for stand #4 (2424m)

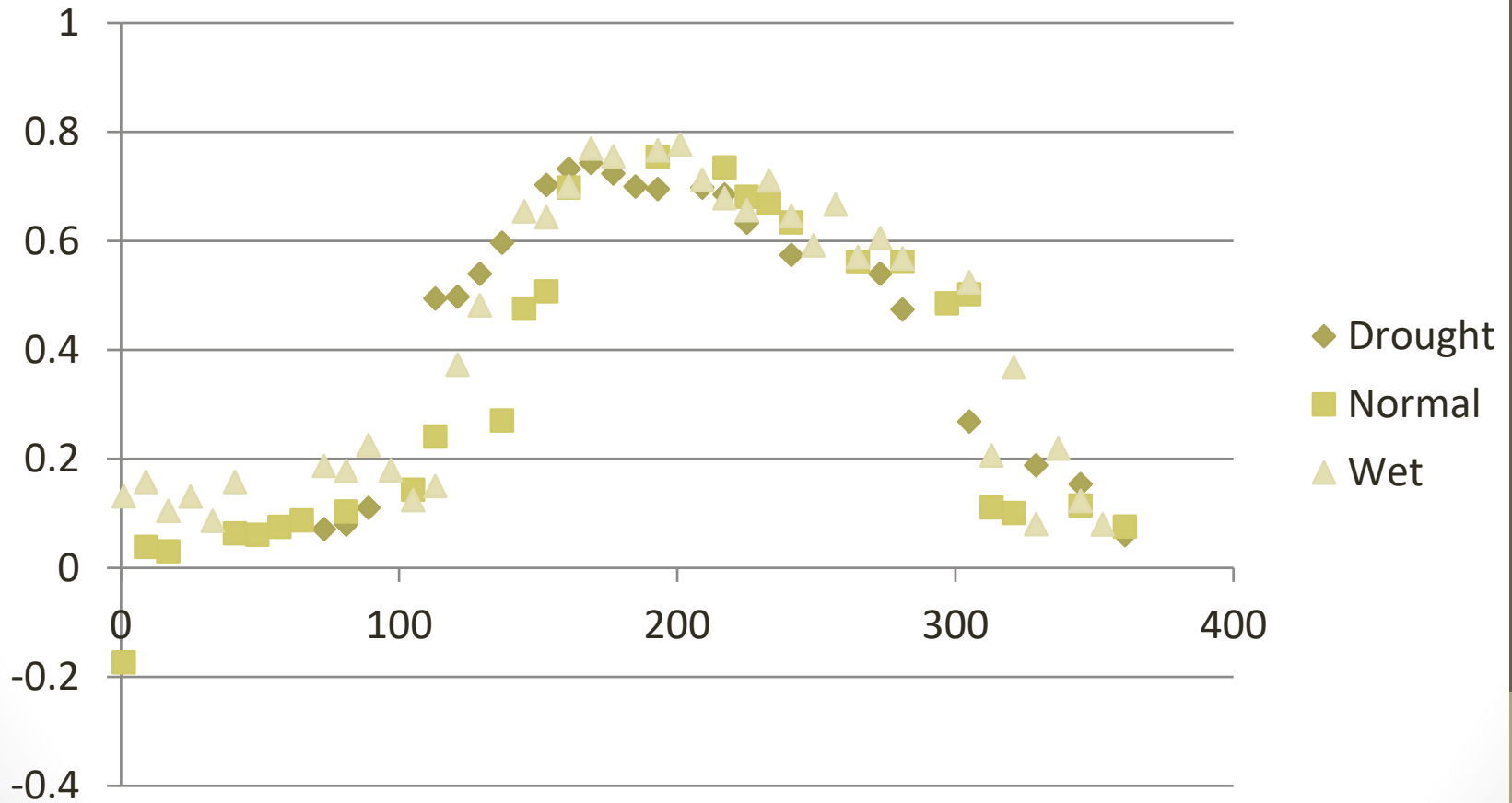
STAND #1 (2272m)



RESULTS - PRECIPITATION

- The rest of the stands did not show variation in their peak NDVI values in normal, drought and wet years
- Start and end of the season
 - We did not notice any difference among the stands for the 3 years

STAND #3 (2421)



Discussion

- Potential sources of error
 - Human aspects
 - Elevation range can be higher
 - Current study (2272m – 2670m) – we can increase this range
 - Field survey first?
 - Stand conditions, presence of other species
 - Include more than one year for each condition and calculate average

Conclusion

- Elevation influences the start of the season in all but one stand (2421m)
- Elevation did not influence the peak NDVI values for stands growing above 2420m
 - Two stands growing at lower elevations had lower NDVI values
- Precipitation affected growth in only two of the six stands
 - In these two stands:
 - NDVI values were lowest in drought years (as anticipated)
 - NDVI values were highest in normal years (not anticipated result)

Acknowledgements

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