Introduction, For example, (from NZQA exemplars):
It has been speculated in the media that the area of sea ice on the planet is decreasing. Is this actually happening? If so what is causing such changes?
How fast is the decrease? What would this mean for the area of sea ice in the Arctic? Would the habitats of animals such as polar bears be destroyed? The natural resources defence council (NRDC) report (http://www.nrdc.org/globalwarming/qthinice.asp) states that although local temperatures fluctuate naturally, over the past 50 years the average global temperature has increased at the fastest rate in recorded history. Other impacts will include sea level rise, decreases in the amount of sea ice and more frequent and intense storm events.

## The Problem

I am going to investigate whether or not there is a decreasing trend in the area of sea ice in the Arctic and if so what is the rate of such a change.

I expect that the area of sea ice will show a gradual decrease, as I have heard various reports in the media suggesting that the ice caps are melting.

## Plan

I will use INZIGHT to create a series of times series graphs on the quantity of sea ice in the Arctic (in millions of km squared).

## Analysis

### Long Term Trend

The long term trend shows a gradual decrease from January 1990 to March 2011. The trend level decreased from about 10 million km2 in 1993 to about 9 million km2 in 2011. This is a decrease of about 1/18 = 0.06 million km2 or 60 000 km2 per year.

Around 2007 there was an increase for about a year of about 1 million km2, then the trend started to decrease again.

### Seasonal Effect

The seasonal pattern of the area of Arctic Sea Ice is very consistent.

Peak months are usually February/March and are around 4 million km2 above the trend. The troughs are usually August/ September and are around 5 million km2 below the trend. The peaks correspond with mid-summer and the troughs with mid-winter in the Northern hemisphere.

### Unusual features (1995 and 2007)

There were two slightly unusual drops (dips) in the trend, one in 1995 and the other in 2007. I would have to research further to find reasons for these.

### Residuals

The residuals range between -1 and 1 million km2.

The biggest *individual* residual was in 2007 when it was around 1 million km2 below the trend line. This residual represents 1 /11x100= about 9% of the overall range so is not particularly significant and should not affect my predictions.

(Teaching Note from Auckland Uni: any *individual* residual of less than 10% of the overall range is not considered to be significant.)

### Component Contribution to Series Variation

*The main source of variation in the area of Arctic Sea Ice is the seasonal component. This accounts for about 82% of the overall variation. Trend and residual components account for the remaining variation in the series.*

### Predictions

*I have produced predictions for the next 24 months, together with their prediction intervals*

*For example, in March 2013, I predict that there will be around 12.4 million km2 of Arctic Sea Ice. I am 95% confident that the true area of Arctic Sea Ice will be between 10.2 and 14.6 km2.
Because the majority of residuals are very small (less than 10%) I think that my predictions will be reasonably accurate.*

## Conclusion

After a visual inspection of the predicted data I am confident that the model provides a good fit as the differences between the fitted data and the raw data are very small. The small size of the residual values, especially in comparison with the overall variation in the area of Antarctic Sea Ice also supports the model being a good fit.

Contextual reflection (from NZQA exemplar)
This forecast would be of interest to scientists studying the climatic processes of the Earth, Environmental Groups (e.g Greenpeace) as well as scientist studying animal which lives at the Arctic Region. As the area of Arctic sea ice decreasing would have an impact on the climate of the region, possibly contributing to global warming as the melting of sea ice mean that there is more heat absorbed by the sea water than previously, heating up the ocean. The Arctic Sea Ice is the habitat of Polar Bears and would have an impact on how the polar bears live. Environmental groups may want to alert the general public about the decline in the Arctic Sea Ice to get people to change their lifestyles to lessen their carbon footprints.

My findings of a gradual decrease in the mean area of sea ice in the Arctic are partially supported by other research from NASA which states the area is decreasing by about 4% per decade. They also identified a record low for the mean area of sea ice in the Arctic in 2007 but a possible reason for this was not identified.

More recent research (ref BBC sept 2013) suggests that rather than the *area* of sea ice, we should be investigating the changing *volume* of sea ice to get a more reliable assessment of the changes now underway in the northern polar region.