As light from distant galaxies propagates through the Universe, it's path can be deflected by the local matter distribution, an effect called gravitational lensing. As a result, when we view distant galaxies we observe both a change in the shape of it's image, as well as a change in it's position and size. Cosmic shear is the study of the first of these effects, and statistical analysis using galaxy ellipticities has proven a very promising tool for probing cosmology (see Bartlemann and Schneider for a review). However, as shear analysis requires accurate shape measurement, it's measurement has proven a particularly difficult task [ref Great], with measurements sensitive to the Point Spread Function and pixelisation, as well as physical contamination from intrinsic galaxy alignments.

With many current and upcoming large scale surveys such as CFHT, DES and Euclid, it is becoming more important than ever to understand what gains there are to be made in exploiting the other half of the lensing signal. As well as a distortion in the observed shape of a galaxy, gravitational lensing by foreground large scale structure can cause the amplification of the flux of sources as their size is magnified, and a change in their observed positions. Direct observations of the induced change in size of a lensed body is the most obvious measure of the magnification effect, and magnification has been successfully detected using a combination of the change in sizes of a lensed population of galaxies and a change in their magnitudes in [ref Schmidt]. However, due to the nature of the measurements required to detect size change due to magnification, it suffers from many of the same systematics listed for cosmic shear above. In [ref Buise] it was shown that these systematics may limit the use of size change for ground based surveys where the effects of PSF are largest, however for space based surveys with smaller PSF and higher signal to noise, the statistical power of size magnification can rival cosmic shear, and may be an excellent complement to shear analyses.

Another recent technique to use the magnification part of the lensing signal uses a fundamental plane relation to relate the effective radius of galaxy, which is altered by magnification, to the galaxies surface brightness and stellar velocity dispersion, both of which remain unaltered.

The most common technique uses fluctuations in the observed number density of sources as a probe of magnification, called magnification bias. Observationally, the observed number density of sources is altered due to magnification in two ways, the dilution of sources as the solid angle behind the lens is stretched, and the (de-)amplification of sources as their fluxes are (de-)magnified below or above the survey flux limit. Lensing can therefore induce non-vanishing angular number density contrast correlations between a background distribution of sources and foreground large scale structure which are sensitive to cosmology through the distribution of matter and it's evolution, and distance measures.

The early history of using magnification bias to measure magnification proved controversial with early attempts at measuring changes in number density of a background set of quasars due to foreground LSS commonly in disagreement, and with measurements that gave amplitudes of correlations far larger than theoretical predictions (ref Scranton et al provides a concise summary of early literature). However, the successful measurement of number density contrast correlations between background quasars and foreground galaxies using the Sloan Digital Sky Survey in (ref Scranton 2005), and later using high redshift Lyman break galaxies as the background in CARS (ref HH), laid the basis for the use of magnification as a probe of cosmology and large scale structure.

In contrast to cosmic shear analysis, which has seen a recent concentrated effort by the lensing community to remove or understand measurement or statistical systematics, magnification bias as a probe of cosmology is relatively less mature. The reasons for this are simple, for a given sample of galaxies the signal to noise for magnification bias is expected to be smaller, as the shot noise in the shear case is reduced by factor of the intrinsic ellipticity dispersion for each ellipticity component (see Section). However it should be noted that we expect to be able to use a greater number of galaxies in a magnification analysis (provided accurate photometry is taken for these galaxies) than for cosmic shear, as the measurement itself is easier and does not require accurate shape measurement, and this should go some way to offsetting the discrepancy in signal to noise between shear and magnification. Magnification bias is mainly limited by errors in photometry. In particular, the amplitude of the number density contrast correlation from magnification is smaller than that induced by the intrinsic clustering of galaxies due to their dark matter environment. Previous analyses have attempted to remove most of this contamination by choosing carefully selected foreground and background populations which are spatially disjoint (such as HH, van Wearbeke or Scranton which chooses to use quasars as background as galaxy and quasar populations are generally well segregated in redshift), or in down weighting close pairs using the nulling technique (ref BJ and AH). Errors in the determination of the photometric redshift of a galaxy sample can then cause the intrinsic clustering of spatially close populations to be mis-interpreted as a magnification signal, giving spurious results. Further, dust extinction and fluctuation of the magnitude zero points over the survey area can produce fluctuations in number density that mimic the magnification signal, and remain relatively unexplored.

In this paper we consider the