

# Near-IR Selected Quasars in the NDWFS Bootes Field

Richard Green  
Kitt Peak National Observatory



KITT PEAK NATIONAL OBSERVATORY

## Work of the NDWFS Quasar Team:

Scott Croom (AAO)

Steve Warren (Imperial College, London)

Patrick Hall (Princeton)

Michael Brown (NOAO)

Arjun Dey (NOAO)

Buell Jannuzi (NOAO)

Malcolm Smith (AURA OSS)

Dara Norman (NOAO/CTIO)

Glenn Tiede (Bowling Green)

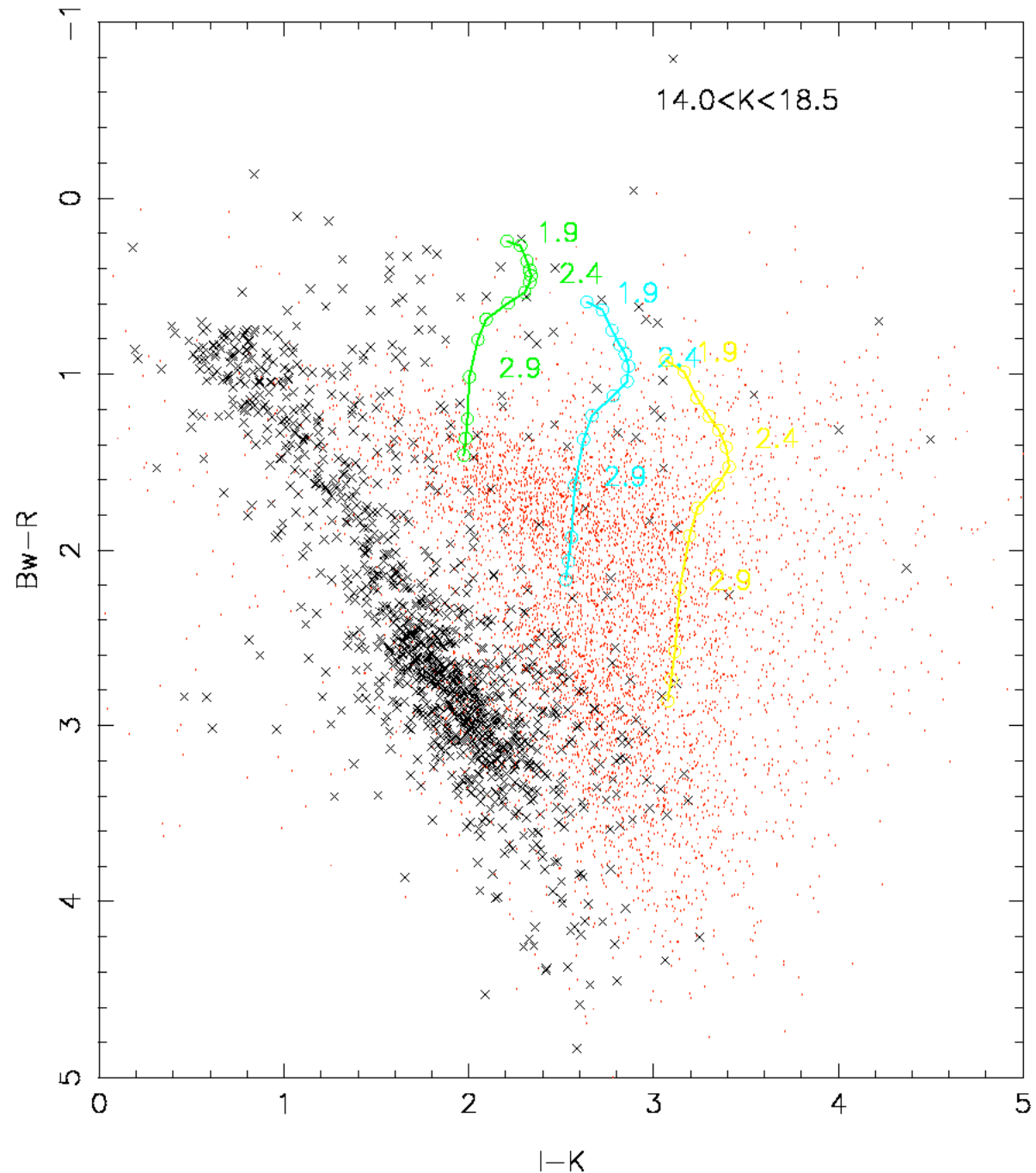
Paul Smith (Steward Obs/U Arizona)

# Scientific Goals

- We report preliminary results from a survey to construct a complete, near-IR selected sample of quasars from the NOAO Deep Wide-Field Survey.
- The scientific goals are to
  - compare the apparent volume densities of color outlier samples selected with optical and K-band limits;
  - detect a complete sample of quasars in the "redshift desert"  $2.5 < z < 3.2$ ;
  - determine the population fraction of moderately reddened quasars;
  - ultimately measure the K-band luminosity function to  $z=4$ .
- The selection technique is to identify color outliers among stellar objects, guided by model expectations.



- Croom's plot illustrates synthesized colors of the SDSS composite quasar spectrum as a function of redshift with different amounts of extinction in the quasar rest frame.
- The LMC extinction law was used. Loci from blue to red in (I-K) are  $E(B-V)=0$ ,  $E(B-V)=0.1$  mag, and  $E(B-V)=0.2$  mag.

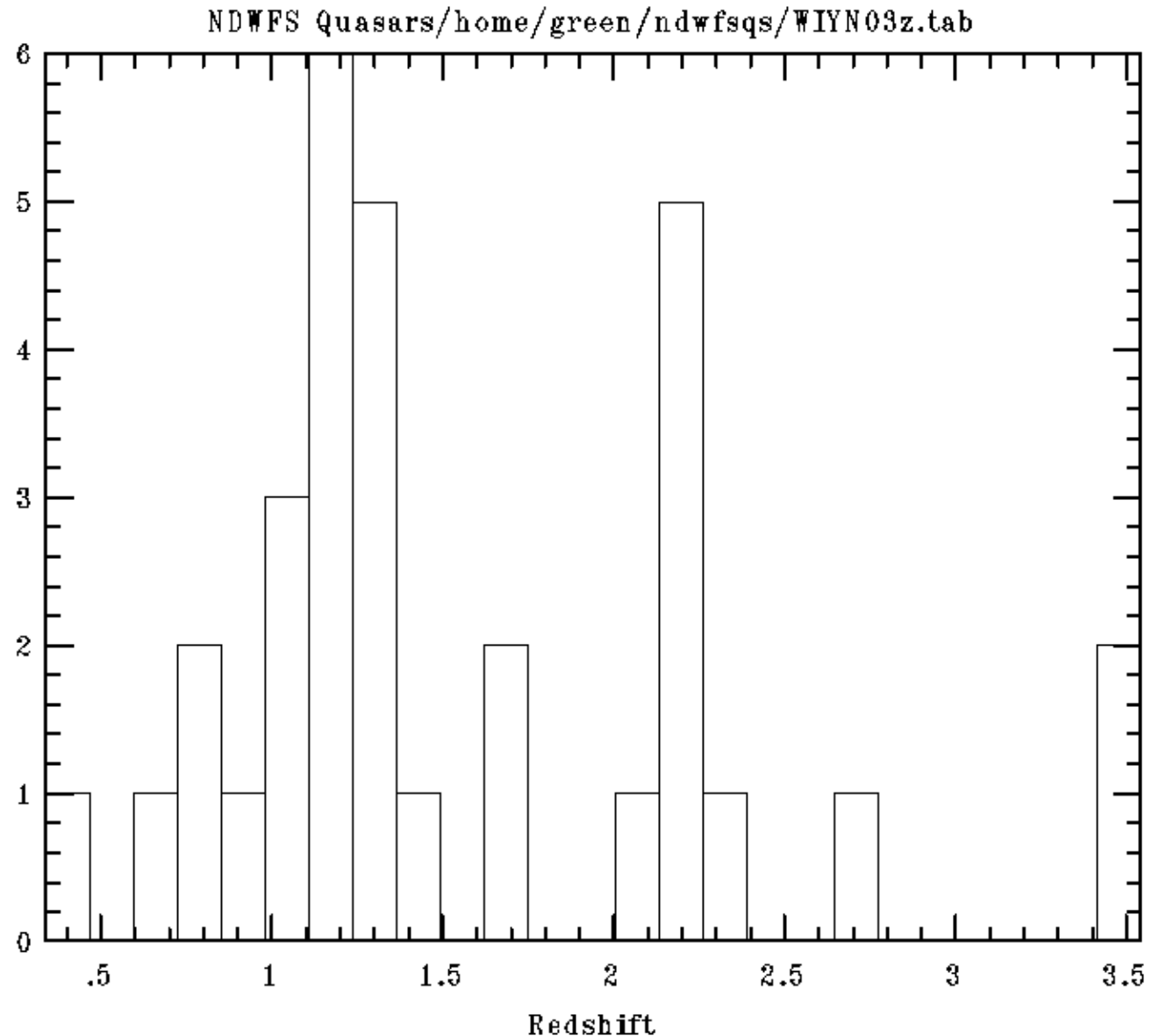


# Spectroscopic Follow-Up Observations

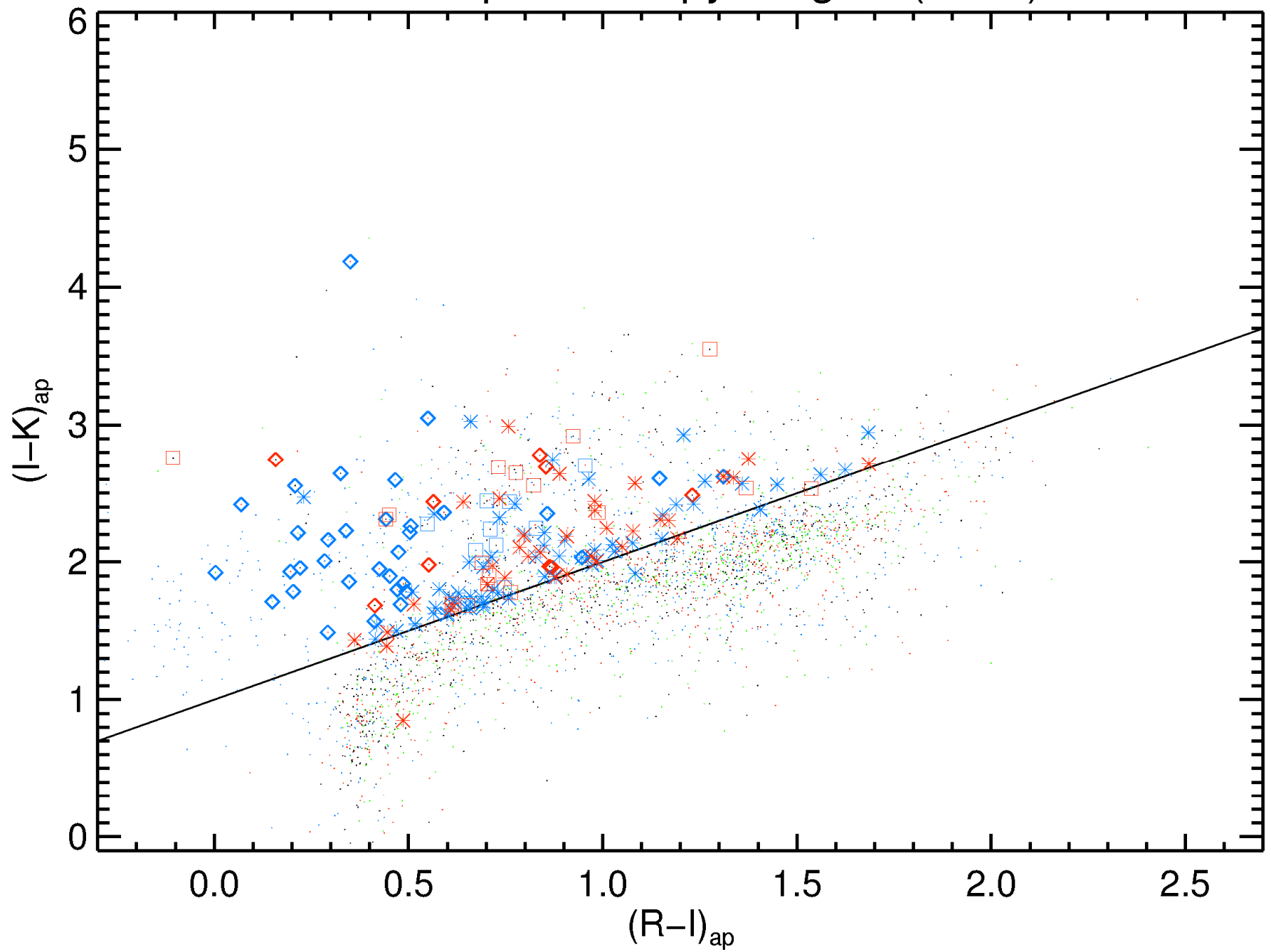
- The criterion  $(I-K) > 1 + (R-I)$  distinguishes reddened quasars from the stellar locus for the first experiment in selection.
- A generous stellarity cut includes some compact galaxies, which are interesting in their own right.
- One area of the Bootes Field of  $\sim 0.85$  sq. deg. was investigated with 3 configurations of the WIYN / Hydra multi-fiber spectrograph.
- Each configuration targeted  $\sim 70$  different objects, many very faint.
- Exposure time was 220 minutes/configuration. Three were taken in 1" or better seeing in clear or thin cirrus conditions.
- Classifiable spectra were obtained for (nearly) all objects with  $R \leq 20.4$  mag.
- Given our spectroscopic completeness, the color selection criterion, and the sample limit of  $K < 18.5$ , the typical  $(R-I) \sim 0.4$ . That value is expected for unreddened objects with the template SED.

# Results

- 28 broad-line quasars were identified, of which 26 were within the reliable ID limit.
- The 2 reddest and faintest objects were consistent with  $E(B-V) \geq 0.04$ .
- The redshift distribution is non-uniform, indicative of large-scale structure, with a substantial peak at  $z \sim 1.1$ .



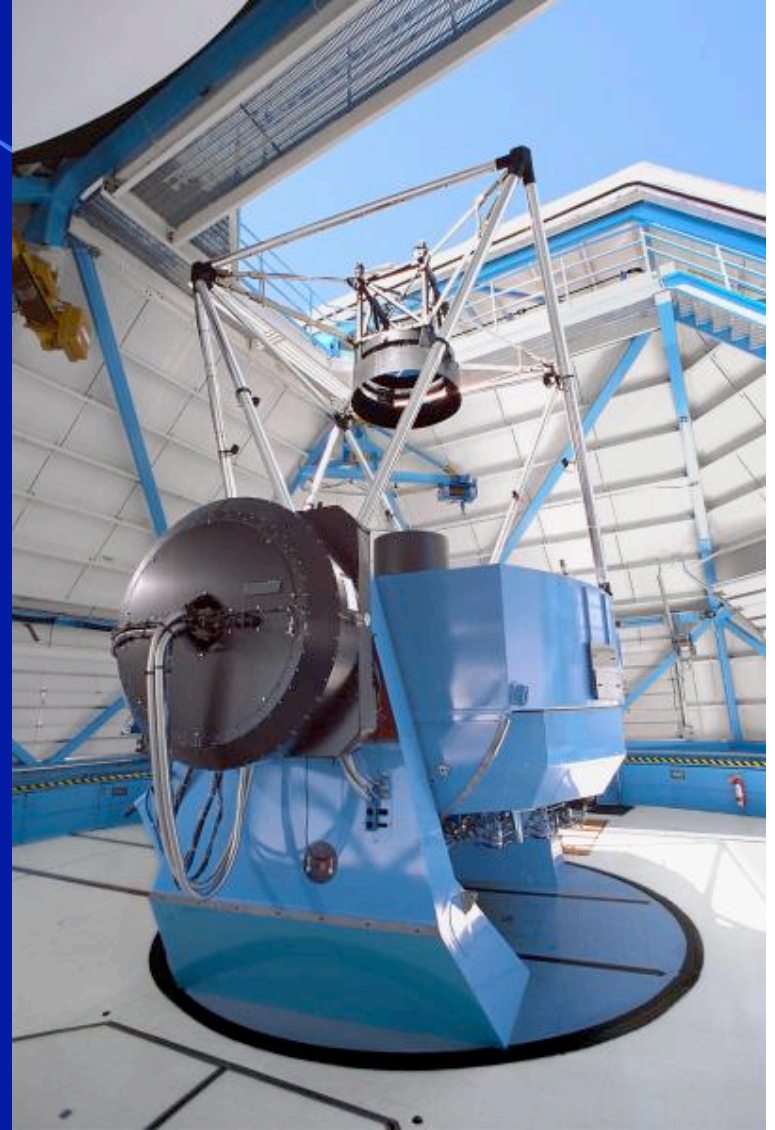
# WIYN Spectroscopy Targets (2003)



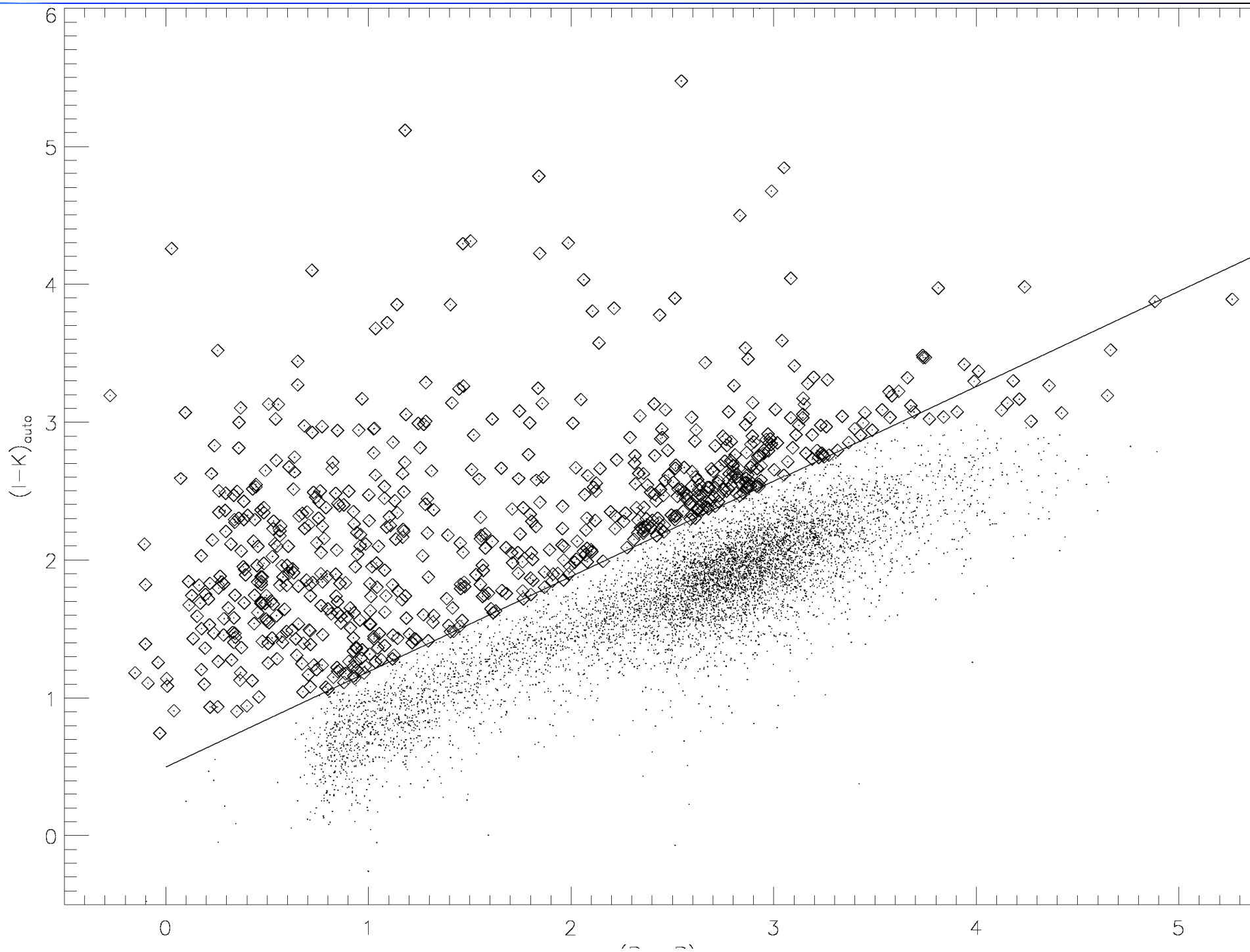


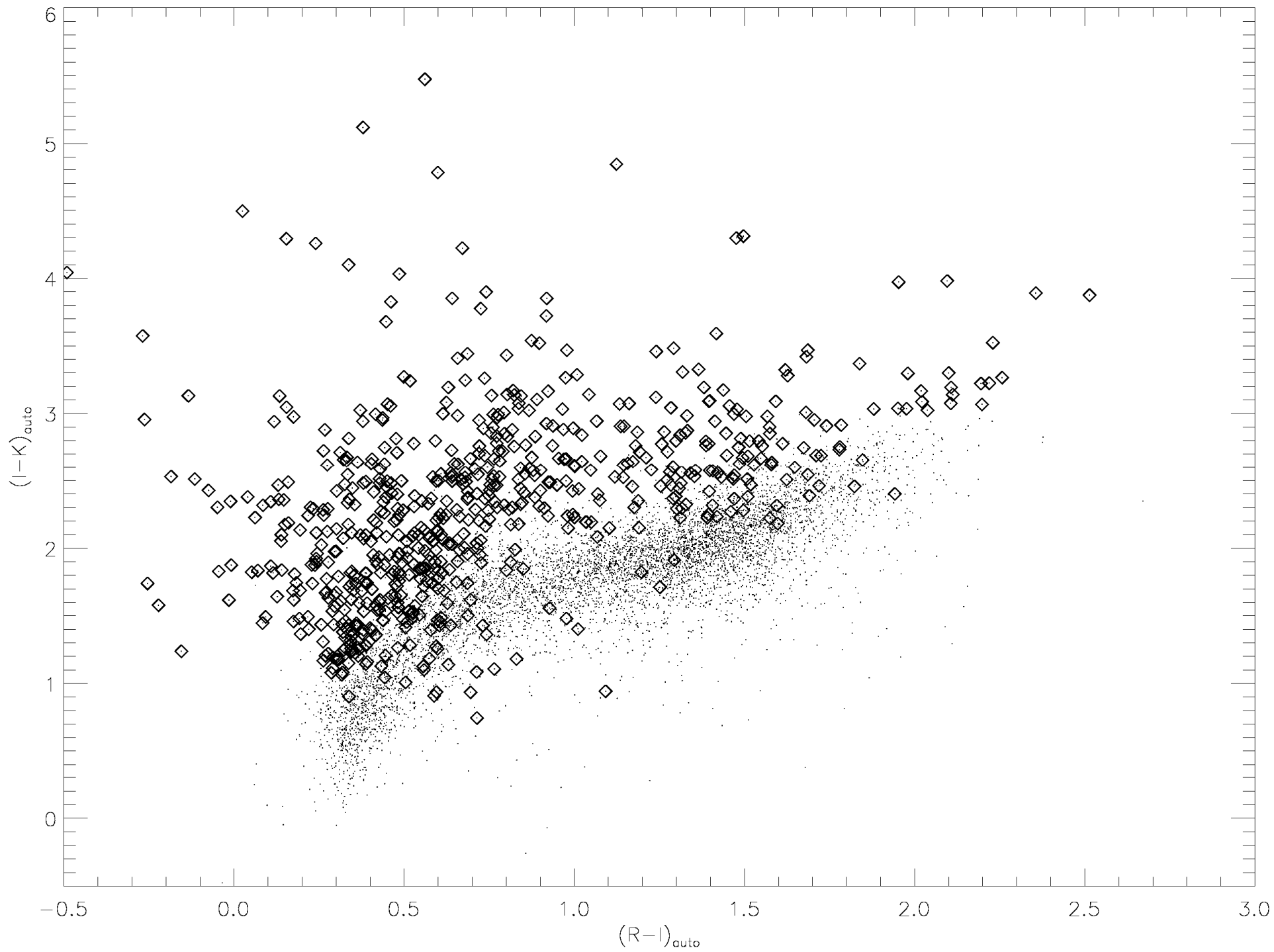
# Modified Selection

- Inclusion of the very deep Bw data creates a baseline of over a factor of 5 in wavelength.
- It should enable selection of “blue excess” objects and a more complete census of lower  $z$ , mildly reddened objects.
- Note the presence of non-stellar energy distribution objects selected by including Bw that fall on the stellar locus in RIK.
- For inclusion of higher  $z$  cases, B-dropout objects are included by applying an RIK criterion, but with the cut shifted redward in (I-K) by  $\sim 0.2$  mag to reduce stellar contamination.









# Conclusions

- A sample of color outliers with stellar PSF in BwRIK with  $K < 18.5$  mag contains some 200 objects / sq.deg.
- An RIK-selected prototype sample of color outliers was observed spectroscopically with WIYN Hydra to  $> 1$  mag deeper than the SDSS NGP sample.
- 2 / 28 objects classifiable as broad-line AGN were consistent with intrinsic reddening  $E(B-V) \geq 0.4$  mag.
- The reddest, faintest candidates have not yet been confirmed, creating interesting discovery space for greater reddening and higher  $z$ .