Supplementary material

Comparing observer performance in vegetation records by efficiency graphs derived from rarefaction curves

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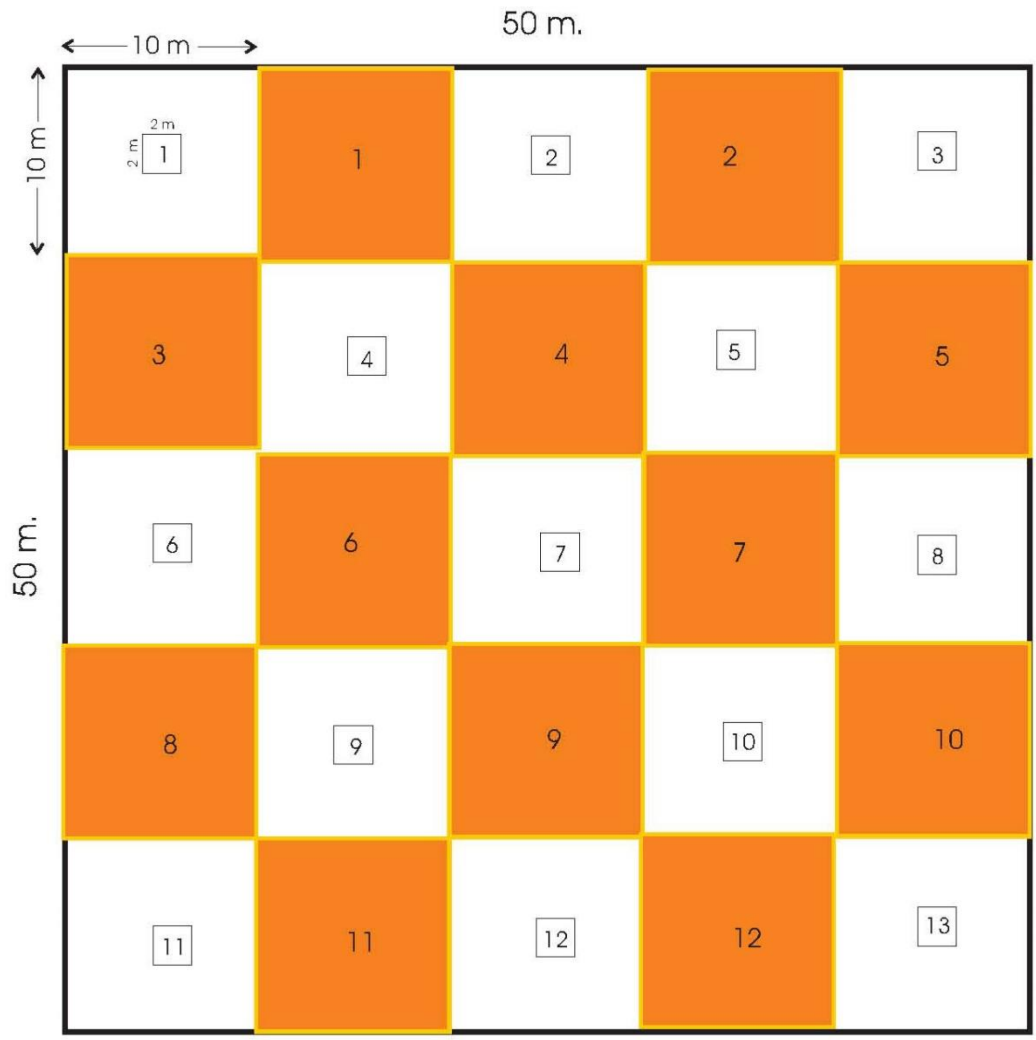

Figure S1: Scheme of the sampling design for intercalibration at two scales. Orange quadrats were used for 100-m^2 series and white ones for the 4-m^2 series (from Canullo et al., 2010: Fig. 2).

a b

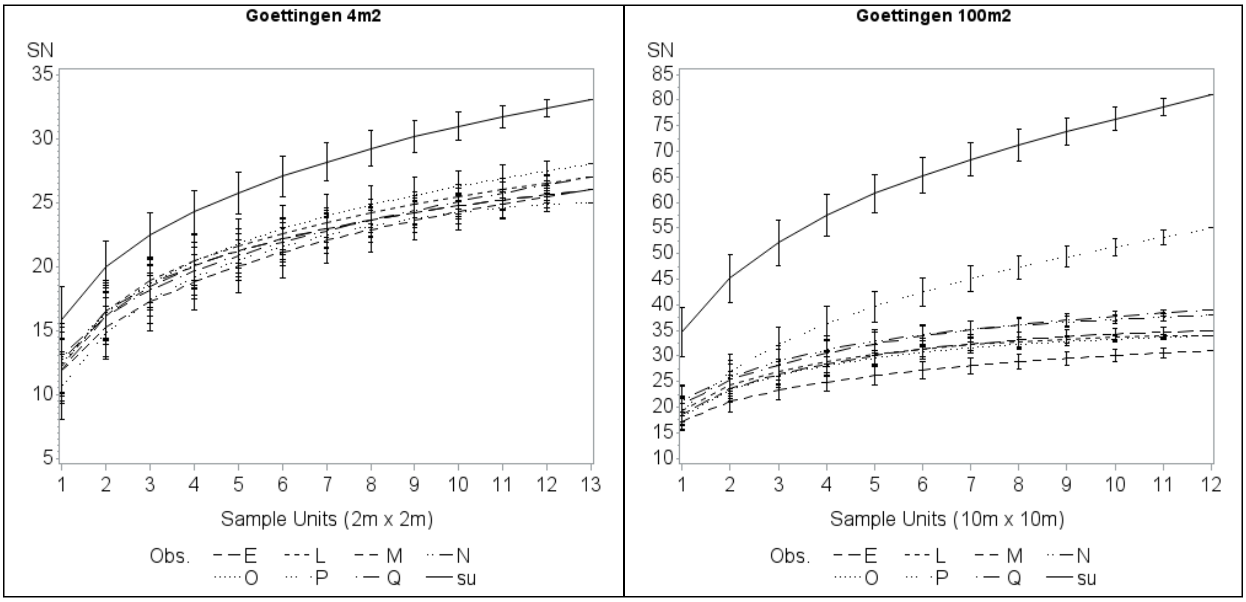

Figure S2: Rarefaction curves of vascular plant species number (SN) ± standard deviation for (a) 2 m x 2 m subplots (left) and (b) 10 m x 10 m subplots (right) for 7 observers (E - Q) at Göttingen (GO). Curves of the expected species numbers as set union (su) over all observers are included. Sample unit is the number of permutated and fully enumerated combinations of all subplots.

a b

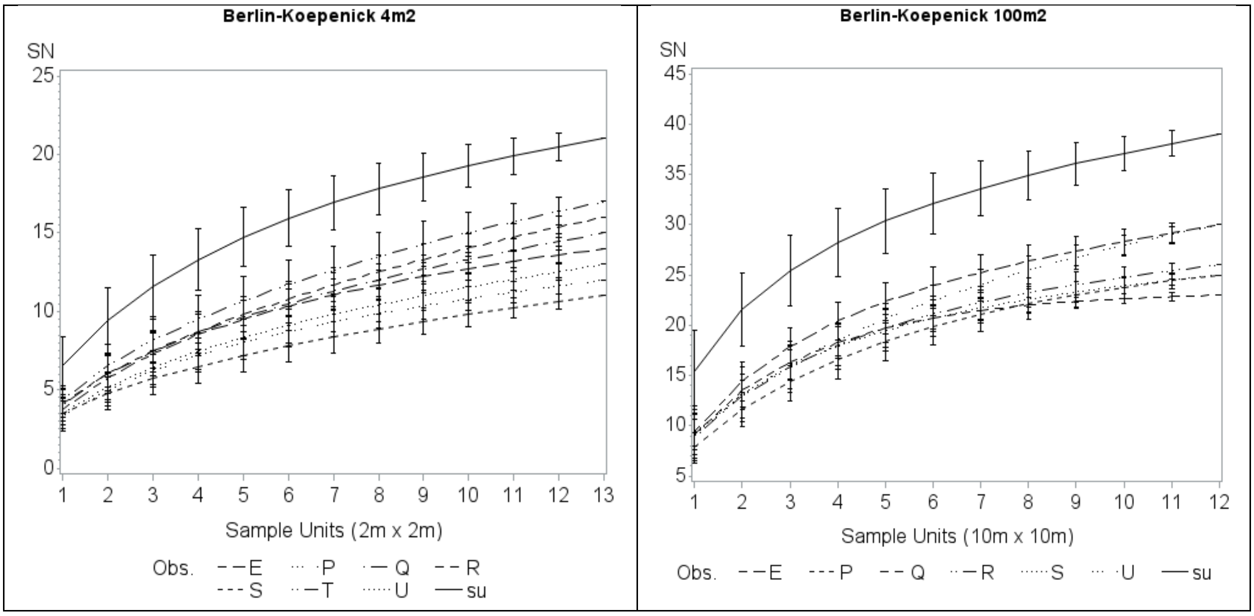

Figure S3: Rarefaction curves of vascular plant species number (SN) ± standard deviation for (a) 2 m x 2 m subplots in 7 observers (E – U) and (b) 10 m x 10 m subplots in 6 observers (E - U) at Berlin-Köpenick (BK). Curves of the expected species numbers as set union (su) over all observers are included. Sample unit is the number of permutated and fully enumerated combinations of all subplots.

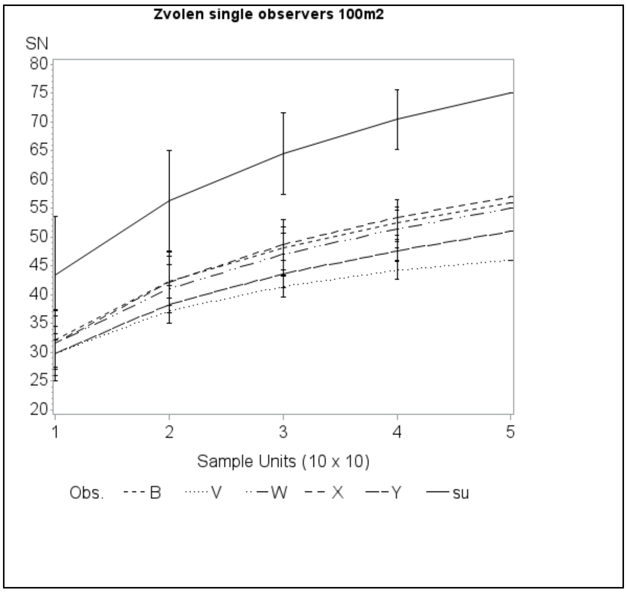

Figure S4: Rarefaction curves of vascular plant species number (SN) ± standard deviation for five 10 m x 10 m subplots (left) with 5 single observers (B – Y) at Zvolen (ZV). A curve of the expected species number as set union (su) over all observers is included. Sample unit is the number of permutated and fully enumerated combinations of all 5 subplots.

Reference

Canullo, R., Campetella, G., Allegrini, M.-C., 2010: 1st trans-national training and field inter-comparison course in ground vegetation. Corpo Forestale dello Stato, 48 p., not published.

Example of an SAS Programme for complete enumeration of rarefaction curves for single observers including an overall reference for a course with 5 subplots

```
/*SAS (9.4) Programme rarefaction with complete enumeration
    from Walter Seidling,
    17.8.2011 - 21.2.2019
    for five 100-m2 subplots
=============================================================*/
DATA in0a (drop = plotser teamser plot spe); set sasuser.slovakia;
    subplot=(substr(plot,2,2))/1; art=spe; plotser=substr(plot,1,1);
teamser=substr(team,1,1);
    if plotser='A' and teamser='T' then output; run;
proc sort data=in0a; by team subplot; run;
/*------ reordering plotids in steadily increasing order, if necessary --*/
Data in0; set in0a; if subplot=2 then subplot=1;
if subplot=5 then subplot=2; if subplot=7 then subplot=3; if subplot=11 then
subplot=4; if subplot=12 then subplot=5; run;
/*--------------------------------------- Calculation set union curve ---
Removal of team-information*/
data maxcurve1 ; set in0 (drop = team); run;
Proc sort data=maxcurve1; by subplot; run;
Proc freq data=maxcurve1; table Art / out=maxcurve2; by subplot; run;
/*--------------------------------------- Data expectation (set union)*/
DATA maxcurve3; set maxcurve2 (drop = count percent); team = 'EX'; run;
/*--------------------------------------- Join with data from observers */
data in00 ; set in0 maxcurve3; run;

DATA in (drop = subplot); set in00; plot1 = subplot; run;
proc sort data=in; by team plot1; run;

/*============= All 10-m2-plots per team =====================*/
Proc means data=in noprint;
   var plot1;
   by team plot1;
   output out=lev1 n=nart;
run;
Proc means data=lev1 noprint;
   var nart;
   by team;
   output out=xlev4 mean=xnart std=snart p95=enart;
run;

DATA level1 (drop = _type_ _freq_); set xlev4;
  xmins=xnart-snart; xplus=xnart+snart; unit = 1; area = 100;
run;

/* ===== All combination of 2 subplots ===================*/
DATA into2 (drop = team art subplot); set in00; teamart = team||art;
                   plota=subplot; plotb=subplot; run;
Proc sort data=into2; by plotb; run;
/*      Calculation all combinations */
DATA comp2;
DO plota=1 to 4;
  DO plotb=2 to 5;
     co = plota*100 + plotb;
     if plotb > plota then output;
  end;
end;
run;
/*     Assigning species */
Proc sql; create table d4
          as select comp2.plota, comp2.plotb, comp2.co, into2.teamart
          from comp2, into2
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```
                where comp2.plota = into2.plota;
quit;
Proc sql; create table d4b
          as select comp2.plota, comp2.plotb, comp2.co, into2.teamart
          from comp2, into2
              where comp2.plotb = into2.plotb;
quit;
/*  Sorting out doubletons */
data d4add (drop= plota plotb); set d4 d4b; run;
proc sort data=d4add; by co teamart; run;

Proc sql; create table d4sel
          as select co, teamart,
          count (*) as indi
          from d4add
          group by co, teamart order by indi desc; quit;
/*  Separating species and team */
DATA l2 (drop= teamart); set d4sel;
  team = substr(teamart,1,2); Art = substr(teamart,3,27);
run;
proc sort data=l2; by co team ; run;
Proc means data=l2 noprint;
   var indi;
   by co team;
   output out=lev2 n=nart8;
run;
proc sort data=lev2; by team; RUN;
Proc means data=lev2 noprint;
   var nart8;
   by team;
   output out=xlev8 mean=xnart std=snart stderr=enart;
run;

DATA level2 (drop = _type_ _freq_); set xlev8;
  xmins=xnart-snart; xplus=xnart+snart; unit = 2; area = 200;
run;

/*========== All combination of 3 subplots ====================*/
/*   input basic table */
DATA into3 (drop = team art subplot); set in00; teamart = team||art;
    plota=subplot; plotb=subplot; plotc=subplot; run;
Proc sort data=into3; by plotc plotb; run;
/*   Calculation all combinations  */
DATA comp3;
DO plota=1 to 3;
  DO plotb=2 to 4;
    DO plotc=3 to 5;
     co = plota*10000 + plotb*100 + plotc;
     if plotc > plotb > plota then output;
    end;
  end;
end;
run;
/* Assigning species */
Proc sql; create table d6
          as select comp3.plota, comp3.plotb, comp3.plotc, comp3.co,
into3.teamart
          from comp3, into3
              where comp3.plota = into3.plota;
quit;
Proc sql; create table d6b
          as select comp3.plota, comp3.plotb, comp3.co, comp3.plotc,
into3.teamart
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          from comp3, into3
              where comp3.plotb = into3.plotb;
quit;
Proc sql; create table d6c
          as select comp3.plota, comp3.plotb, comp3.co, comp3.plotc,
into3.teamart
          from comp3, into3
              where comp3.plotc = into3.plotc;
quit;
/*   Aggregating and elimination of doubletons   */
data d6add (drop= plota plotb plotc); set d6 d6b d6c; run;
proc sort data=d6add; by co teamart; run;

Proc sql; create table d6sel
          as select co, teamart,
          count (*) as indi
          from d6add
          group by co, teamart order by indi desc; quit;
/* Separating species and team */
DATA l3 (drop= teamart); set d6sel;
  team = substr(teamart,1,2); Art = substr(teamart,3,27);
run;
proc sort data=l3; by co team ; run;
/* Averaging at level of 3 subplots */
Proc means data=l3 noprint;
   var indi;
   by co team;
   output out=lev3 n=nart12;
run;

proc sort data=lev3; by team; RUN;
Proc means data=lev3 noprint;
   var nart12;
   by team;
   output out=xlev12 mean=xnart std=snart stderr=enart;
run;
DATA level3 (drop = _type_ _freq_); set xlev12;
  xmins=xnart-snart; xplus=xnart+snart; unit = 3; area = 300;
run;

/*========== All combinations of 4 subplots ====================*/
/*   Input basic table */
DATA into4 (drop = team art subplot); set in00; teamart = team||art;
    plota=subplot; plotb=subplot; plotc=subplot; plotd=subplot; run;
/*   Calculation of combinations */
DATA comp4;
DO plota=1 to 2;
  DO plotb=2 to 3;
    DO plotc=3 to 4;
        DO plotd=4 to 5;
        co = plota*1000000 + plotb*10000 + plotc*100 + plotd;
        if plotd > plotc > plotb > plota then output;
        end;
    end;
  end;
end; run;
/* 3. Assigning species to combinations */
Proc sql; create table d8
          as select comp4.plota, comp4.plotb, comp4.plotc, comp4.plotd,
comp4.co, into4.teamart
          from comp4, into4
              where comp4.plota = into4.plota;
quit;
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```
Proc sql; create table d8b
          as select comp4.plota, comp4.plotb, comp4.plotc, comp4.plotd,
comp4.co, into4.teamart
          from comp4, into4
              where comp4.plotb = into4.plotb;
quit;
Proc sql; create table d8c
          as select comp4.plota, comp4.plotb, comp4.plotc, comp4.plotd,
comp4.co, into4.teamart
          from comp4, into4
              where comp4.plotc = into4.plotc;
quit;
Proc sql; create table d8d
          as select comp4.plota, comp4.plotb, comp4.plotc, comp4.plotd,
comp4.co, into4.teamart
          from comp4, into4
              where comp4.plotd = into4.plotd;
quit;
/* Aggregating and elimination of doubletons */
data d8add (drop= plota plotb plotc plotd); set d8 d8b d8c d8d; run;
proc sort data=d8add; by co teamart; run;

Proc sql; create table d8sel
          as select co, teamart,
          count (*) as indi
          from d8add
          group by co, teamart order by indi desc; quit;
/* Separating species and team */
DATA l4 (drop= teamart); set d8sel;
  team = substr(teamart,1,2); Art = substr(teamart,3,27);
run;
proc sort data=l4; by co team ; run;
/* Aggregating at level of 4 subplots */
Proc means data=l4 noprint;
   var indi;
   by co team;
   output out=lev4 n=nart16;
run;

proc sort data=lev4; by team; RUN;
Proc means data=lev4 noprint;
   var nart16;
   by team;
   output out=xlev16 mean=xnart std=snart stderr=enart;
run;
DATA level4 (drop = _type_ _freq_); set xlev16;
  xmins=xnart-snart; xplus=xnart+snart; unit = 4; area = 400;
run;

/*==================== Aggregating over total area (all 5 subplots) ====*/
/*   input basic table */
DATA into5 (drop = team art subplot cov); set in00;
    teamart = team||art;
run;
/* Eliminating Doubletons etc.*/
Proc sql; create table d10sel
          as select teamart,
          count (*) as indi
          from into5
          group by teamart order by indi desc; quit;
/* 5. Separating species and team */
DATA l5 (drop= teamart); set d10sel;
  team = substr(teamart,1,2); Art = substr(teamart,3,27);
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run;
proc sort data=l5; by team; run;
/* 6.  Averaging over 500 m2 */
Proc means data=l5 noprint;
   var indi;
   by team;
   output out=lev5 n=nart52;
run;
DATA level5 (drop = _type_ _freq_ nart52); set lev5;
   xnart = nart52; unit = 5; area = 500;
run;

/*=============== Aggregation all levels ===================*/
DATA lev_all; set level1 level2 level3 level4 level5;
  lgarea = log(area); lgaz = log(xnart);
run;

/*==== Modification of Team names (anonymization, if necessary) ========*/;
data anno; set lev_all;
    if team = 'T1' then team = 'A'; if team = 'T2' then team = 'B';
    if team = 'T3' then team = 'C'; if team = 'T4' then team = 'D';
    if team = 'T5' then team = 'E'; if team = 'EX' then team = 'su';
run;

/*=================== Species number - areal plot ===================*/;
goptions reset=all hsize=5 vsize=5;
  title h=1.6 'Zvolen teams 100m2';
  axis1 label=(h=1.9 'SN') value=(h=1.8);
  axis2 label=(h=1.9 'Sample Units (10m x 10m)') value=(h=1.8) minor=none;
  legend1 label=(h=1.9 'Obs.') value=(h=1.8);
  symbol1 value=circle i=join color=grey;
  symbol2 value=circle i=join color=red;
  symbol3 value=circle i=join color=blue;
  symbol4 value=circle i=join color=magenta;
  symbol5 value=circle i=join color=lime;
  symbol6 value=none i=join color=black;
Proc gplot data=anno;
 plot xnart * unit = team / vaxis=axis1 haxis=axis2 legend=legend1;
run;

/* HiLo-Plot; xmins and xplus taken from previous calculations xmins and
xplus newly calculated */
DATA AZ (drop = xnart snart enart xmins xplus); set anno; NS = xnart;
DATA AZp (drop = xnart snart enart xmins xplus); set anno; NS = xnart -
snart;
DATA AZm (drop = xnart snart enart xmins xplus); set anno; NS = xnart +
snart;
DATA AZhilo; set AZ AZp AZm;
run;

goptions reset=all hsize=5 vsize=5;
  title h=1.6 'Zvolen team 100m2';
  axis1 label=(h=1.9 'SN') value=(h=1.8) order=(20 to 80 by 5);
  axis2 label=(h=1.9 'Sample Units (10 x 10)') value=(h=1.8) minor = none;
  legend1 label=(h=1.9 'Obs.') value=(h=1.8);
  symbol1 value=none i=hilotj color=black l=2;
  symbol2 value=none i=hilotj color=black l=33;
  symbol3 value=none i=hilotj color=black l=42;
  symbol4 value=none i=hilotj color=black l=20;
  symbol5 value=none i=hilotj color=black l=4;
  symbol6 value=none i=hilotj color=black l=1;

Proc gplot data=AZhilo/* AZm*/;
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```
 plot NS * unit = team / vaxis=axis1 haxis=axis2 legend=legend1;
run;

/*========= Modul Calculation of team-specific efficiences ======*/
Proc means data=az noprint; var NS; by unit; output out=az_plus max=NS_ex;
run;
DATA relfac (drop = _freq_ _type_); merge az AZ_plus; by unit;
  success = NS/NS_ex *100;
run;
DATA darstell; set relfac; if team = 'su' then delete; run;

goptions reset=all hsize=5 vsize=5;
  title h=1.6 'Observer efficiency team 100m2';
  axis1 label=(h=1.9 'Effic [%]') value=(h=1.8);
  axis2 label=(h=1.9 'Sample Units (10 x 10 m)') value=(h=1.8);
  legend1 label=(h=1.9 'Obs.') value=(h=1.8);
  symbol1 value=circle i=join color=red;
  symbol2 value=circle i=join color=blue;
  symbol3 value=circle i=join color=black;
  symbol4 value=circle i=join color=lime;
  symbol5 value=circle i=join color=grey;
Proc gplot data=darstell;
 plot success * unit = team / vaxis=axis1 haxis=axis2 legend=legend1;
run;
/* Efficiency graphs in black and white */
goptions reset=all hsize=5 vsize=5;
  title h=1.6 'Observer efficiency team 100m2';
  axis1 label=(h=1.9 'Effic [%]') value=(h=1.8) /*order=(60 to 80 by 5)*/ ;
  axis2 label=(h=1.9 'Sample Units (10 x 10 m)') value=(h=1.8) minor=none;
  legend1 label=(h=1.9 'Obs.') value=(h=1.8);
  symbol1 value=circle  i=join l=2 color=black;
  symbol2 value=diamond i=join l=33 color=black;
  symbol3 value=square  i=join l=42 color=black;
  symbol4 value=plus       i=join l=20 color=black;
  symbol5 value=triangle i=join l=4 color=black;
Proc gplot data=darstell;
 plot success * unit = team / vaxis=axis1 haxis=axis2 legend=legend1;
run;
```