Bees and other pollinators – a vulnerable guild

Beate Strandberg
bst@dmu.dk

Faggruppen for Biodiversitet – Biodiversitetsseminar, Mols Bjerge 25. oktober 2012

Species conservation, challenges & opportunities

Status
Pollinators in Denmark

Bumblebees: 29 species (21 Bombus spp., 8 Psithyrus spp.) 12 red listed (41 %)

Solitary bees: 238 species, status unknown

Hover flies: 267 species, 82 red listed (31 %)

Butterflies: 77 species, 43 red listed (56%)

Moth: 66 species, 23 red listed (35 %)

Den danske rødliste (http://www.dmu.dk/dyrplanter/redlistframe/)

Calabuig (2000), Dupont & Madsen (2010)

Main factors limiting species and populations

- Availability of source habitats
  - Food
  - Areas for nesting and hibernation
- Diseases
- Parasites
- Toxic compounds incl. pesticides
- Mis-macth between pollinators and food plants

Bumblebees in agricultural areas, status and trends

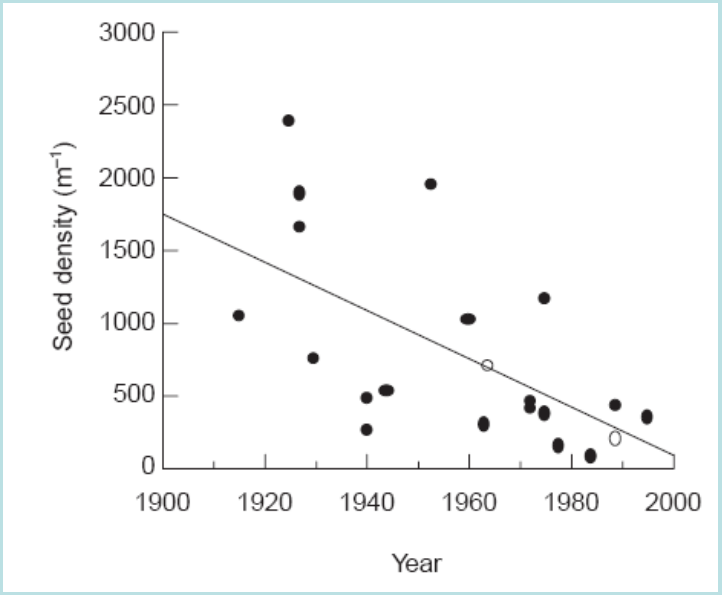
		Red list status	Declining	Stable	Increa-sing	Un-known
Bombus barbutellus	Havesnyltehumle	EN				X
B. campestris	Agersnyltehumle	NT				X
B. distinguendus	Kløverhumle	CR	X			
B. humilis	Foranderlig humle	VU				X
B. subterraneus	Jordboende humle	NT	X			
B. sylvarum	Skovhumle	NT	X			
B. veteranus	Enghumle	VU	x			
B. ruderarius	Græshumle	NT	x			
B. cryptarum	Pilejordhumle	LC				x
B. lucorum	Lys jordhumle	LC			X	
B. terrestris	Mørk jordhumle	LC			x	
B. hortorum	Havehumle	LC		X		
B. hypnorum	Hushumle	LC		X		
B. lapidarius	Stenhumle	LC			X	
B. pascuorum	Agerhumle	LC			X	
B. muscorum	Moshumle	LC	x			
B. pratorum	Lille skovhumle	LC	x			
B. soroeensis	klokkehumle	LC	x			

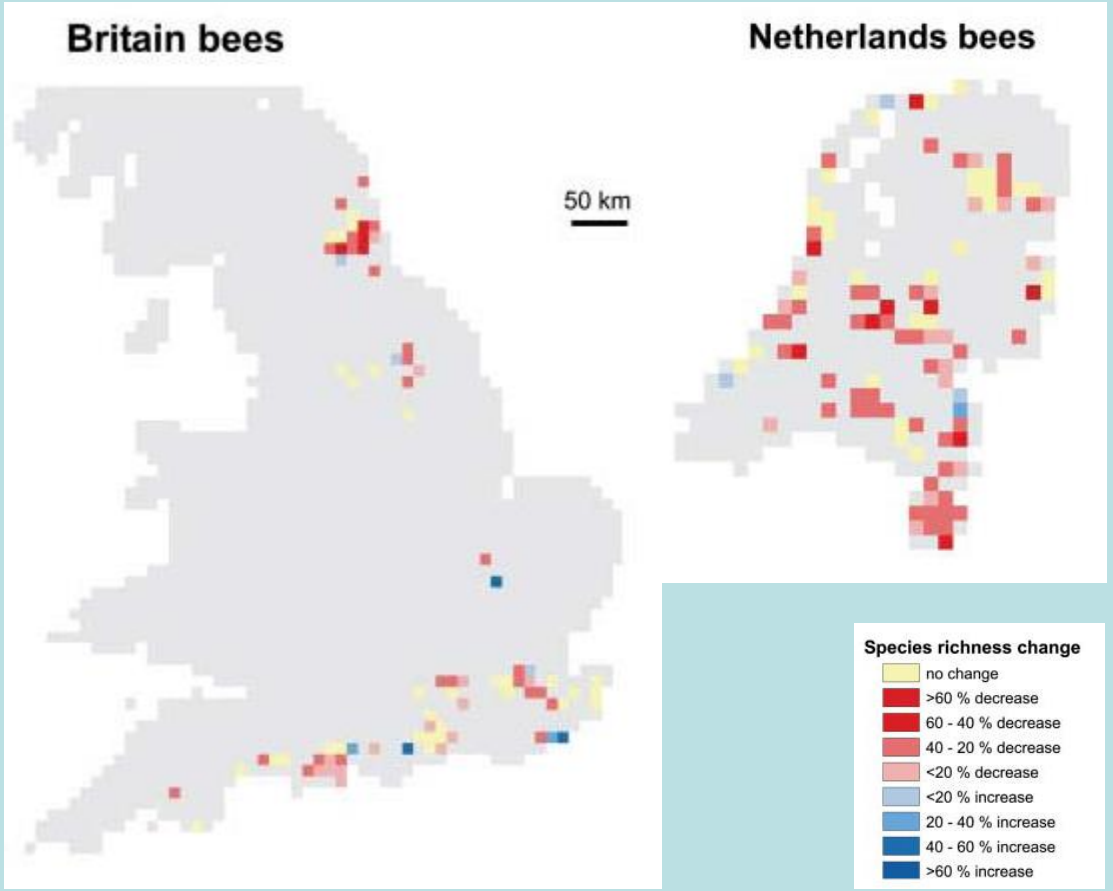
Strandberg & Krogh (2011)

In: Ejrnæs et al. (2011)

Decline in farmland biodiversity

plants, birds and pollinators





Robinson & Sutherland (2002), Biesmeijer et al. (2006)

Bumblebees in red clover fields, historical data (1930'ties)

		Red list status	Declining	Stable	Increa-sing	Un-known
Bombus barbutellus	Havesnyltehumle	EN				X
B. campestris	Agersnyltehumle	NT				X
B. distinguendus	Kløverhumle	CR	X			
B. humilis	Foranderlig humle	VU				X
B. ruderatus	Felthumle	CR	X			
B. subterraneus	Jordboende humle	NT	X			
B. sylvarum	Skovhumle	NT	X			
B. veteranus	Enghumle	VU	x			
B. ruderarius	Græshumle	NT	x			
B. cryptarum	Pilejordhumle	LC				x
B. lucorum	Lys jordhumle	LC			X	
B. terrestris	Mørk jordhumle	LC			x	
B. hortorum	Havehumle	LC		X		
B. hypnorum	Hushumle	LC		X		
B. lapidarius	Stenhumle	LC			X	
B. pascuorum	Agerhumle	LC			X	
B. muscorum	Moshumle	LC	x			
B. pratorum	Lille skovhumle	LC	x			
B. soroeensis	klokkehumle	LC	x			

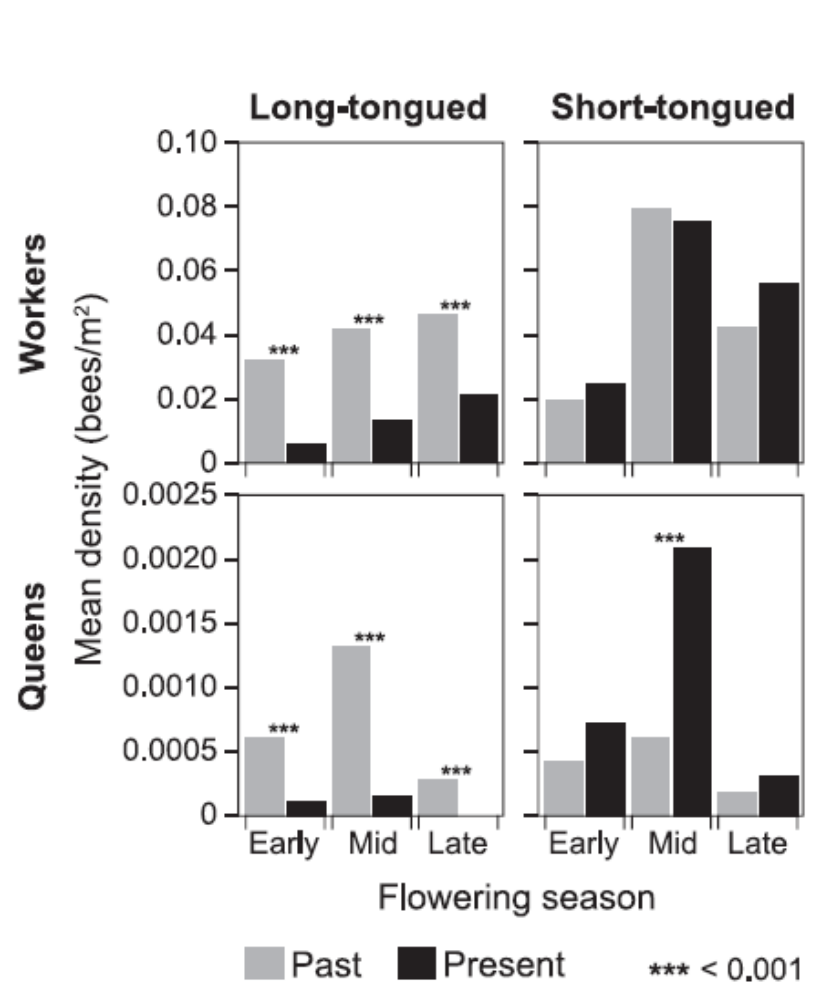
Stapel 1933, Skovgaard 1936

Bumblebees in red clover fields, new data (2008-2010)

		Red list status	Declining	Stable	Increa-sing	Un-known
Bombus barbutellus	Havesnyltehumle	EN				X
B. campestris	Agersnyltehumle	NT				X
B. distinguendus	Kløverhumle	CR	X			
B. humilis	Foranderlig humle	VU				X
B. ruderatus	Felthumle	CR	X			
B. subterraneus	Jordboende humle	NT	X			
B. sylvarum	Skovhumle	NT	X			
B. veteranus	Enghumle	VU	x			
B. ruderarius	Græshumle	NT	x			
B. cryptarum	Pilejordhumle	LC				x
B. lucorum	Lys jordhumle	LC			X	
B. terrestris	Mørk jordhumle	LC			x	
B. hortorum	Havehumle	LC		X		
B. hypnorum	Hushumle	LC		X		
B. lapidarius	Stenhumle	LC			X	
B. pascuorum	Agerhumle	LC			X	
B. muscorum	Moshumle	LC	x			
B. pratorum	Lille skovhumle	LC	x			
B. soroeensis	klokkehumle	LC	x			

Vermouth 2010, Boll 2010, Dupont et al. 2011

Historical changes in bumblebees in red clover fields



Dupont et al. 2011

Bumblebees in red clover fields, short- and long-tounged species

		Red list status	Declining	Stable	Increa-sing	Un-known
Bombus barbutellus	Havesnyltehumle	EN				X
B. campestris	Agersnyltehumle	NT				X
B. distinguendus	Kløverhumle	CR	X			
B. humilis	Foranderlig humle	VU				X
B. ruderatus	Felthumle	CR	X			
B. subterraneus	Jordboende humle	NT	X			
B. sylvarum	Skovhumle	NT	X			
B. veteranus	Enghumle	VU	x			
B. ruderarius	Græshumle	NT	x			
B. cryptarum	Pilejordhumle	LC				x
B. lucorum	Lys jordhumle	LC			X	
B. terrestris	Mørk jordhumle	LC			x	
B. hortorum	Havehumle	LC		X		
B. hypnorum	Hushumle	LC		X		
B. lapidarius	Stenhumle	LC			X	
B. pascuorum	Agerhumle	LC			X	
B. muscorum	Moshumle	LC	x			
B. pratorum	Lille skovhumle	LC	x			
B. soroeensis	klokkehumle	LC	x			

Dupont et al. 2011

Bumblebees in agricultural areas, hedgerows

		Red list status	Declining	Stable	Increa-sing	Un-known
Bombus barbutellus	Havesnyltehumle	EN				X
B. campestris	Agersnyltehumle	NT				X
B. distinguendus	Kløverhumle	CR	X			
B. humilis	Foranderlig humle	VU				X
B. ruderatus	Felthumle	CR	X			
B. subterraneus	Jordboende humle	NT	X			
B. sylvarum	Skovhumle	NT	X			
B. veteranus	Enghumle	VU	x			
B. ruderarius	Græshumle	NT	x			
B. cryptarum	Pilejordhumle	LC				x
B. lucorum	Lys jordhumle	LC			X	
B. terrestris	Mørk jordhumle	LC			x	
B. hortorum	Havehumle	LC		X		
B. hypnorum	Hushumle	LC		X		
B. lapidarius	Stenhumle	LC			X	
B. pascuorum	Agerhumle	LC			X	
B. muscorum	Moshumle	LC	x			
B. pratorum	Lille skovhumle	LC	x			
B. soroeensis	klokkehumle	LC	x			

Navntoft et al. 2011

Plant – pollinator mutualism

- In temperate regions 78 % of all angiosperms are insect pollinated (Ollerton et al. 2011)
- Pollinating insects improve the pollination for 150 (84 %) of the European crops and the value of pollinating insects is estimated to be 22 billion Euro a year in Europe (STEP 2012)
- Insect pollinated plants most at risk due to decline in pollinating insects (Aguilar et al. 2006)
- The biodiversity decline is larger for insect pollinated plant species than for other native plants (Carvell et al. 2006)
- 66 % of bee-pollinated plants have become more rare (Carvell et al. 2006)
- Bumblebees that have become rare are dependent on rare food plants (Kleijn & Raemakers 2008)

Increasing demand for food – increasing agricultural production

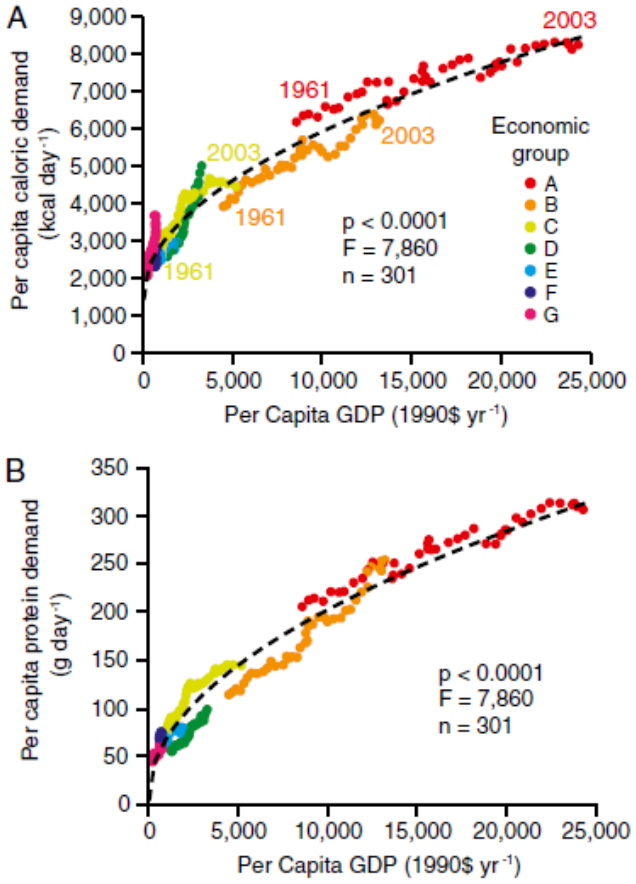
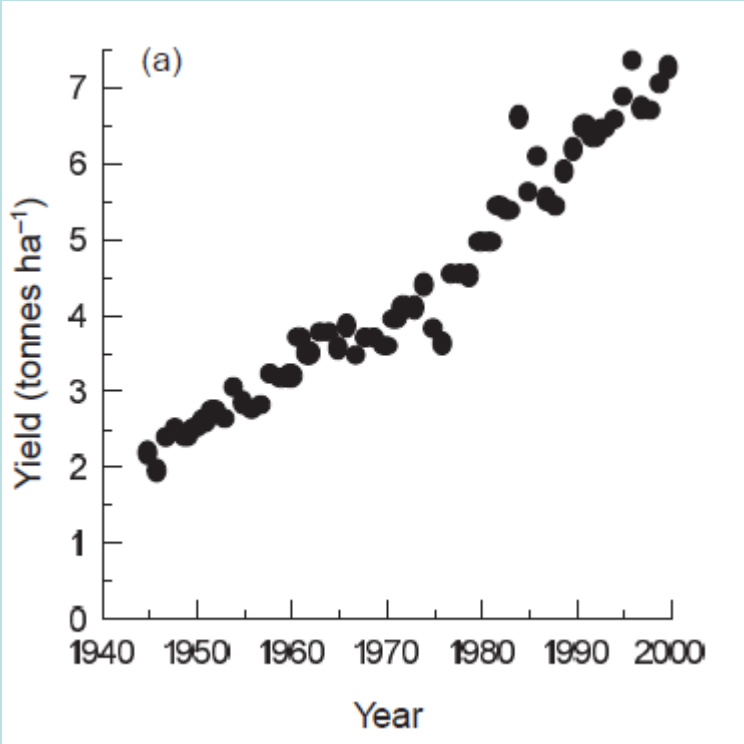


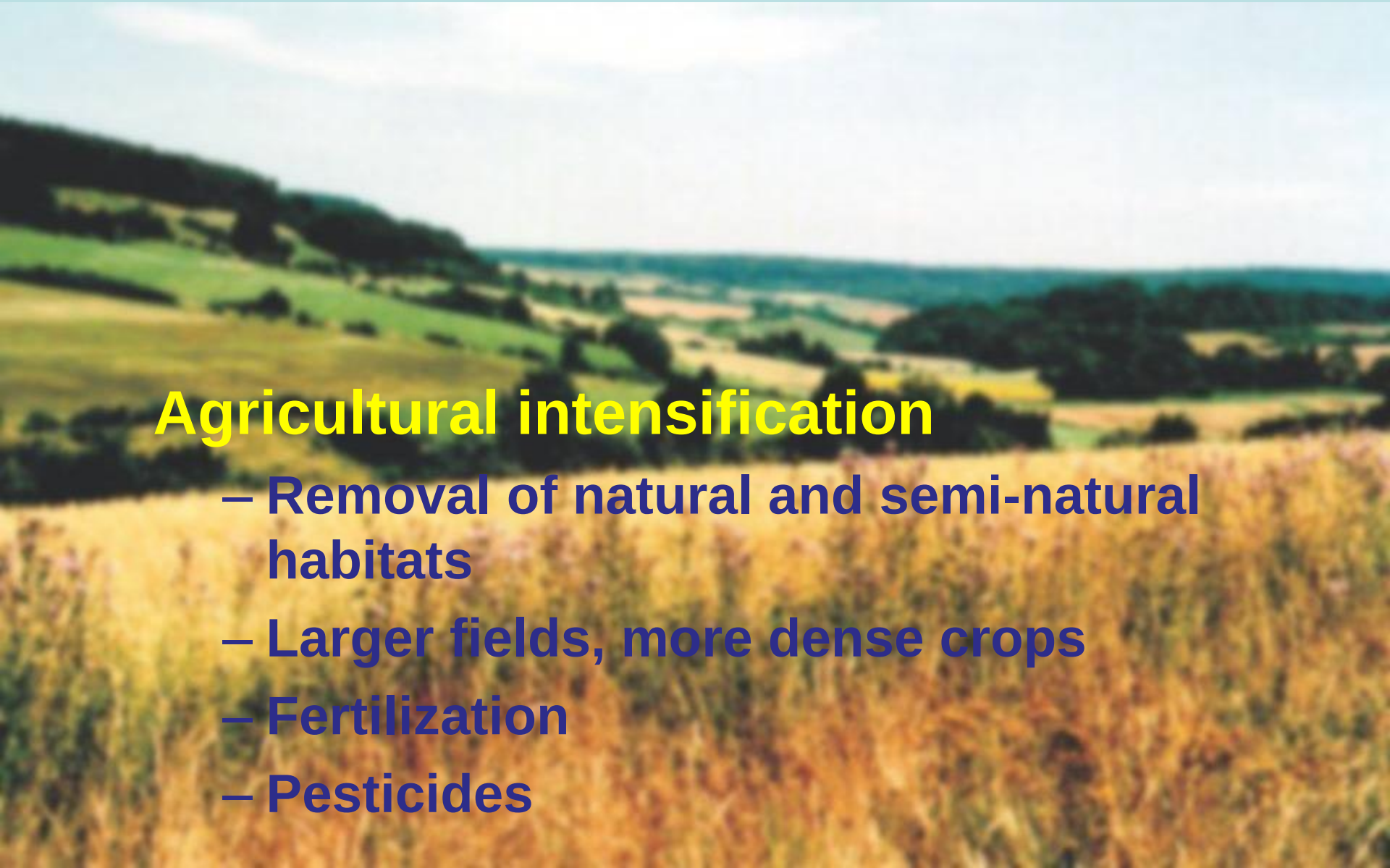
Fig. 1. Annual dependence of per capita demand for (*A*) crop calories and (*B*) protein on per capita real GDP for each of economic Groups A–G (*SI Materials and Methods*). Each color of points shows the trajectory for a particular economic group (one point per year for each group). Curves are fitted to the square root of per capita GDP.

Tilman et al. 2011



Robinson & Sutherland 2002

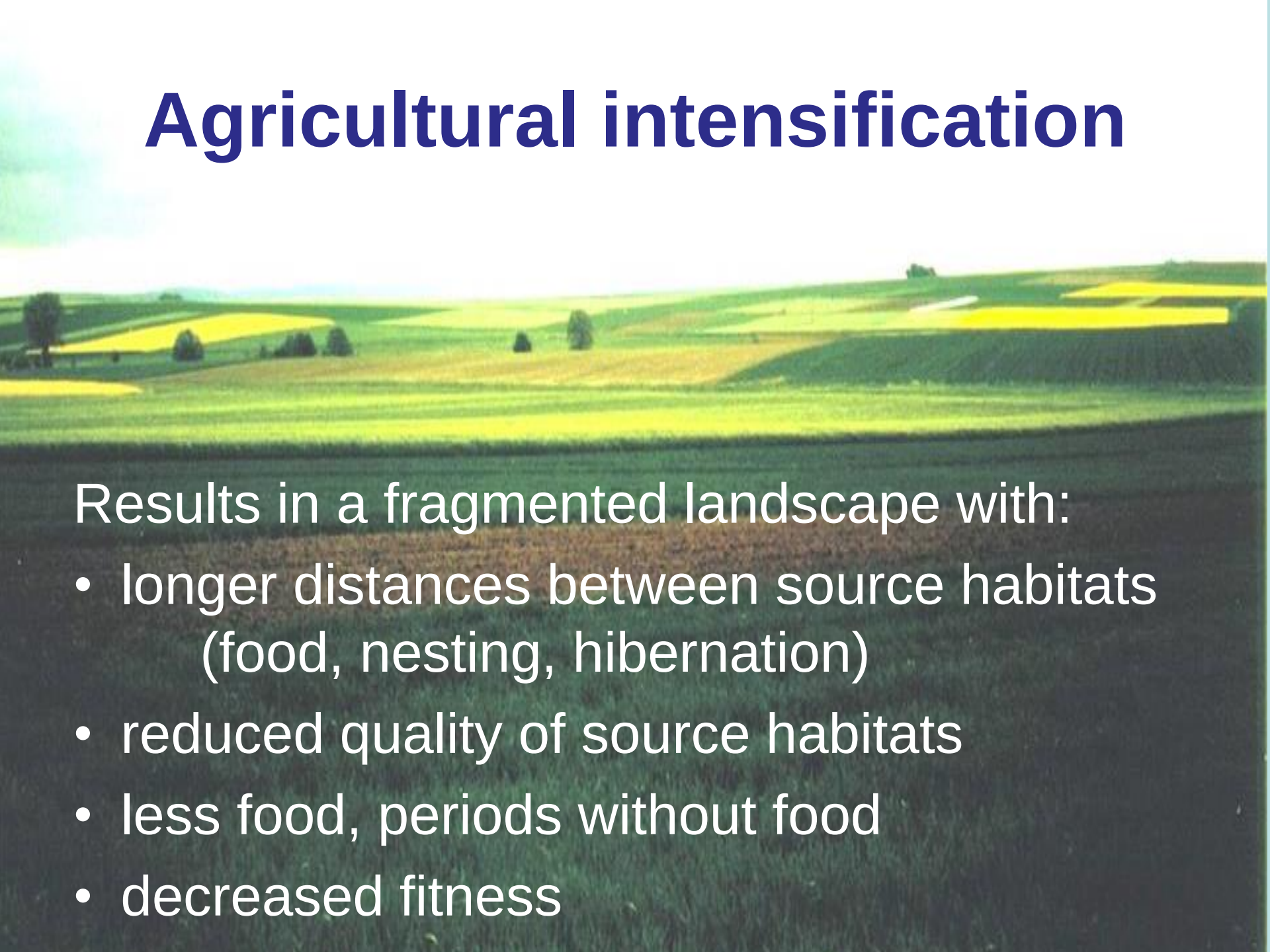
Main threats



Agricultural intensification

- Removal of natural and semi-natural habitats
- Larger fields, more dense crops
- Fertilization
- Pesticides

Agricultural intensification



Results in a fragmented landscape with:

- longer distances between source habitats (food, nesting, hibernation)
- reduced quality of source habitats
- less food, periods without food
- decreased fitness

Conservation and management

Rule of fire-fighters

1. Preserve and protect species and their habitats
2. Reduce harmful effects
3. Restore partly destroyed areas
4. Re-establish populations and habitats

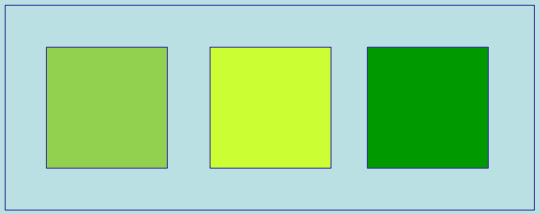
Preserve and protect species and their habitats

- Information on species status (Red list)
- Mapping of species and their habitats (source habitats)
- Knowledge of limiting factors (food, nesting and hibernation habitats)

- Conservation and management

Semi-natural grasslands/hay fields
Source habitats for pollinators

Floral resources and pollinators in well-established hayfields (EcoServe 2011)



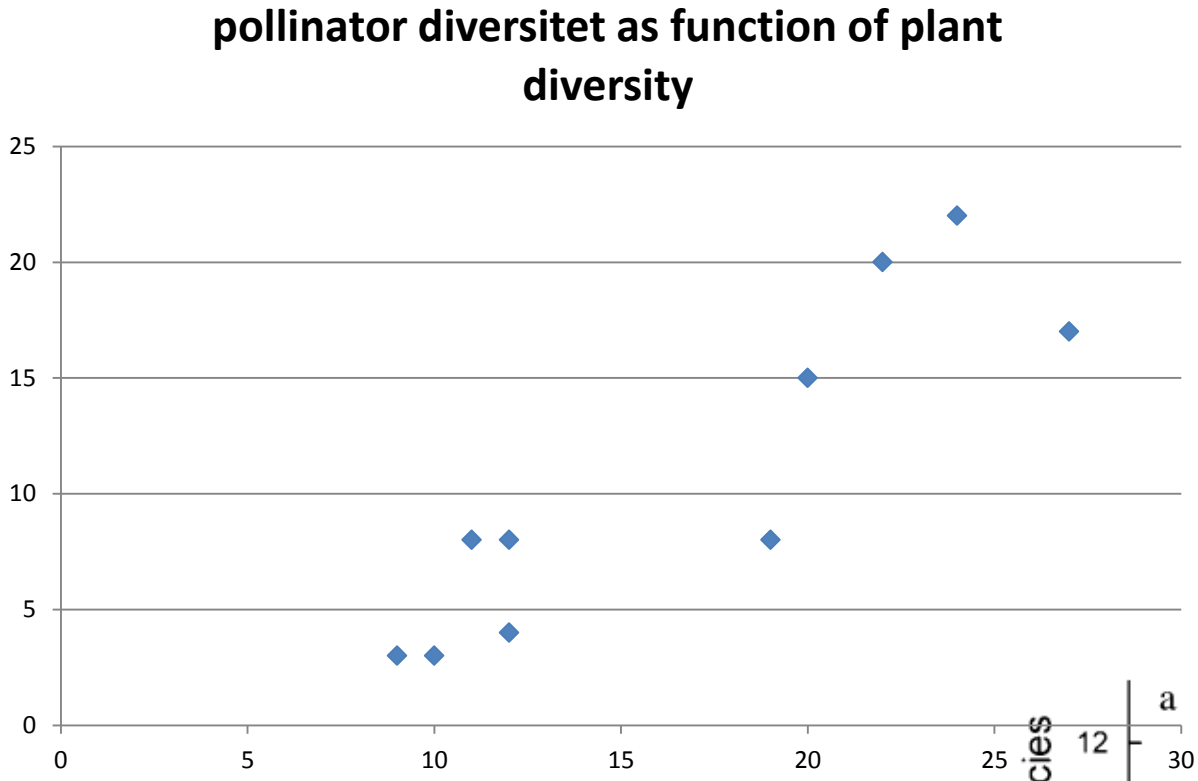
Young (2-3 years) hayfield

5-10 years hayfield

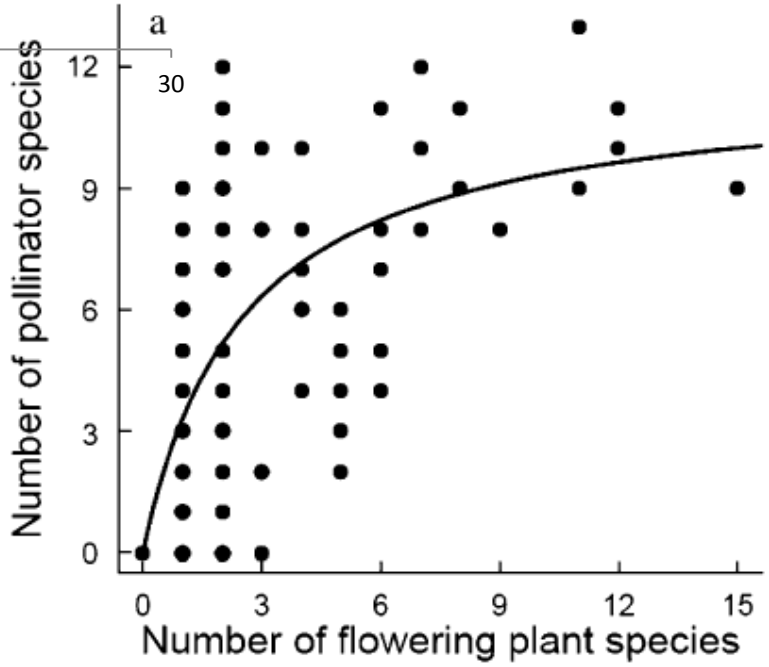
Old (> 10 years) hayfield

Hayfields for analyses of floral resources and pollinators

- 18 hayfields were selected
- 3 areas with 3 hayfields of varying age – all fields were visited four times during the period primo May- ultimo August 2011 (Bording, Funder, Harbovad)
- 1 area with 5 hayfields of varying age – only visited once (Stavad Enge)
- 2 areas with 2 hayfields each of the same age and surrounded by forest, visited 3 times (Fussingø, Salten Skov)

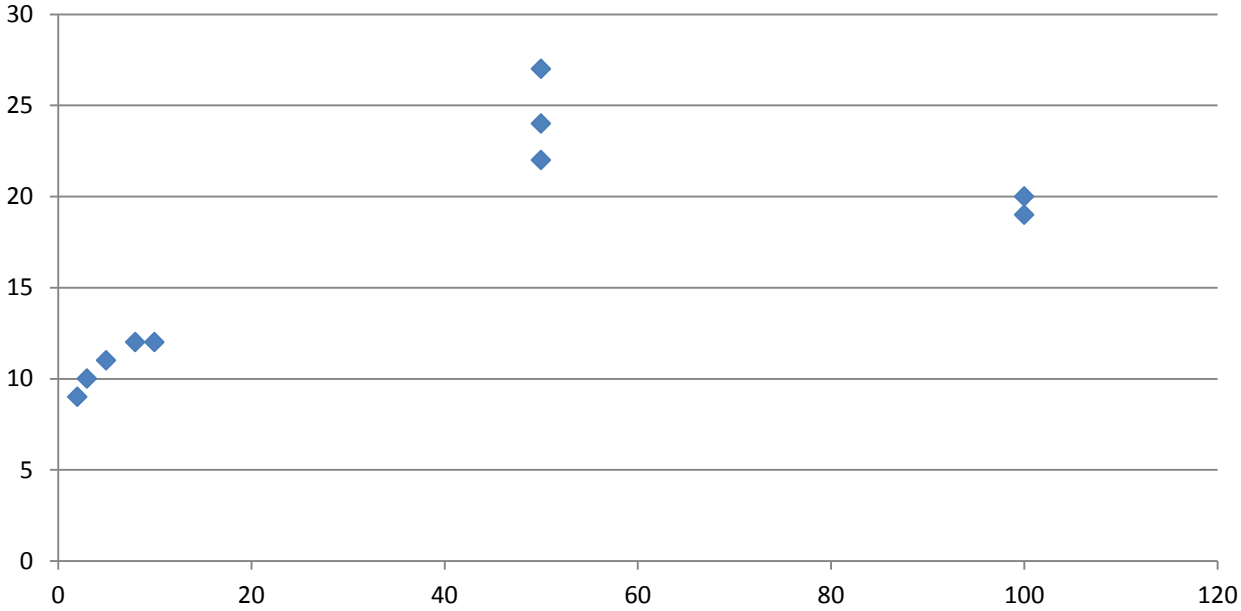


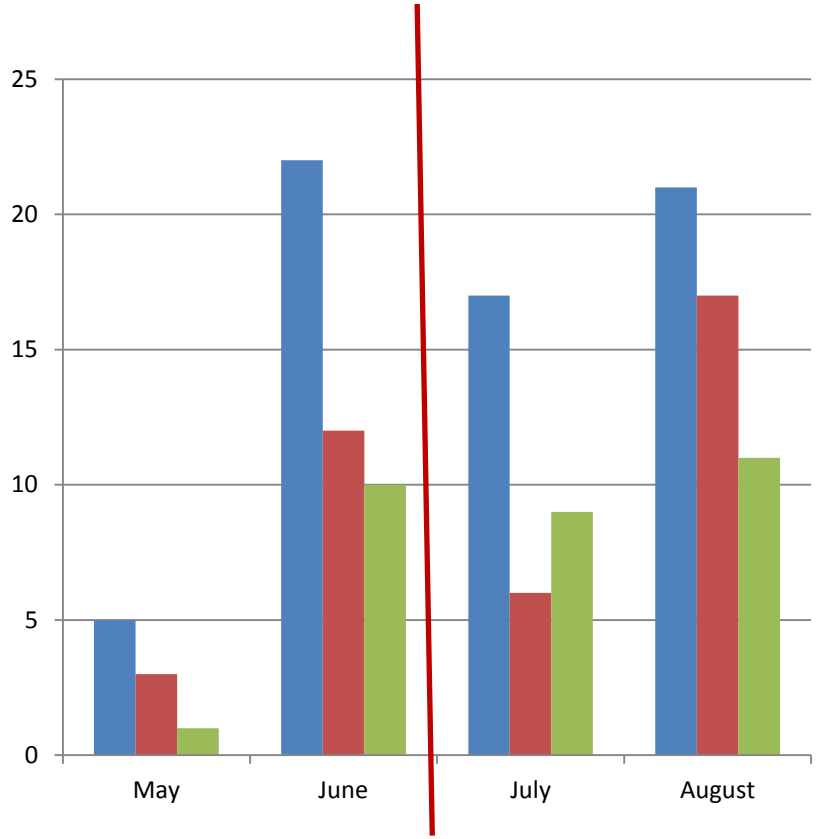
Batáry et al. 2010: Plant species richness is a good predictor of bee diversity



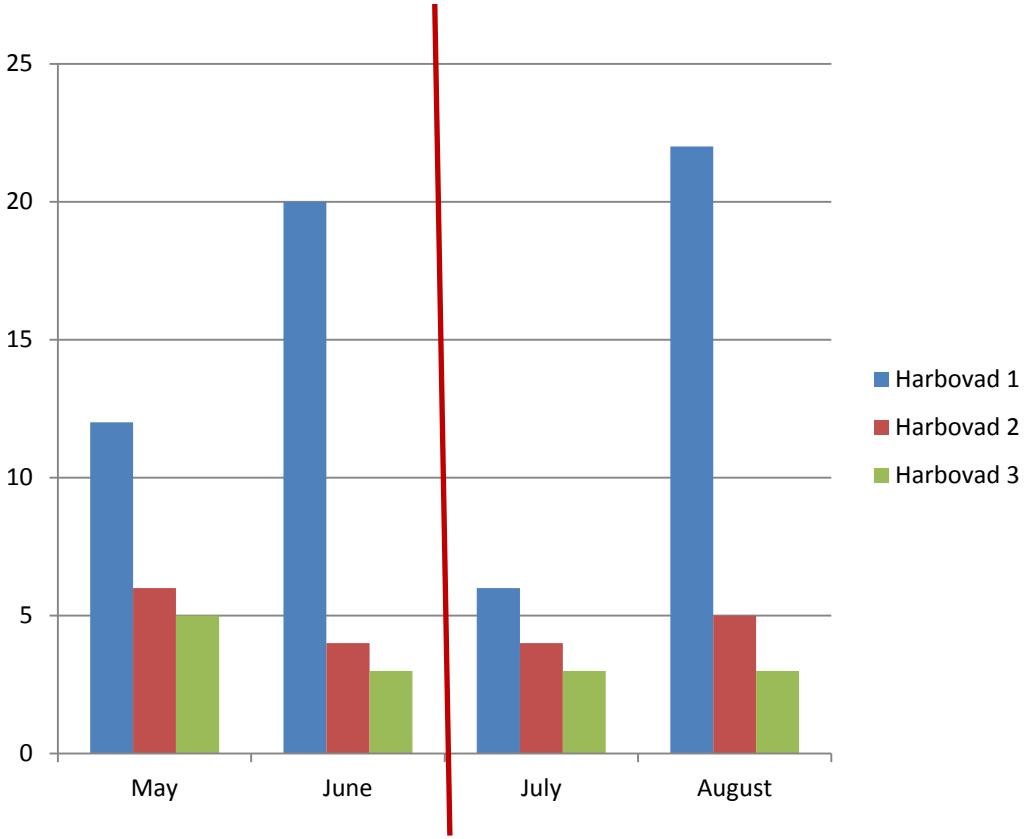
Ebeling et al. 2008

Species richness as function of age





Number of flowering food plants

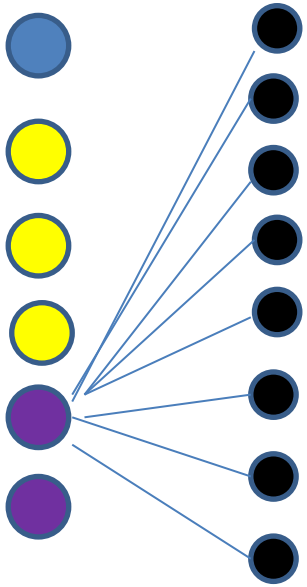


Number of flowering visiting pollinators

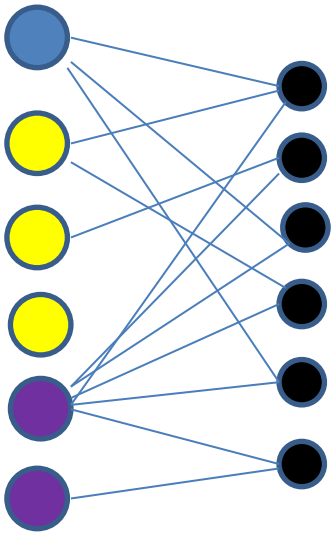
Network: plants -pollinators

Old hayfields
Large diversity of flowering bee-plants

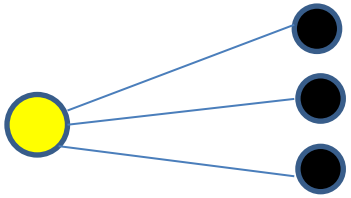
Young hayfields
Low diversity of flowering bee-plants

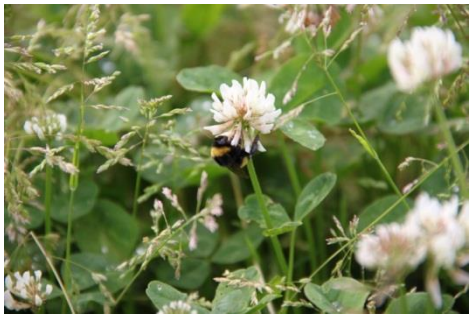


Stavad



Harbovad eller Salten





Reduce harmful effects

- Habitat degradation
- Agricultural practice
  - Use of pesticides, risk assessment of pesticides
  - Use of fertilizers

Restore partly destroyed areas
Re-establish populations and habitats

- AES (Agri-environmental schemes)
  - Organic farming
    - Species groups
    - Landscape heterogeneity
    - Management intensity
    - Time since transition
  - Ecological Compensation Areas (ECA)
  - Flower strips

Hole et al. 2005;Kleijn & Sutherland 2003; Bengtsson et al. 2005; Kleijn et al. 2006; Whittingham 2007; Topping 2011

Planting more pollinator food plants in organic hay fields

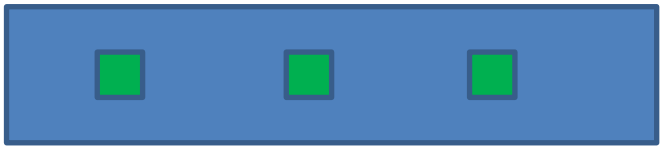
Influence of cutting regime on floral resources

Treatment 1: Standard mix (=ryegrass (*Lolium perenne*), red clover (*Trifolium pratense*) and white clover (*T. repens*)
Treatment 2: Standard mix + common chicory (*Cichorium intybus*)
Treatment 3: Standard mix + plantain (*Plantago lanceolatum*)
Treatment 4: Standard mix + cumin (*Cuminum cyminum*)
Treatment 5: salad burnet (*Sanguisorba minor*) + bird's foot trefoil (*Lotus corniculatus*)
Treatment 6: salad burnet (*Sanguisorba minor*) + alfalfa (*Medicago sativa*)
Treatment 7: salad burnet (*Sanguisorba minor*) + red clover (*Trifolium pratense*)
Treatment 8: dandelion (*Taraxacum sp.*) + bird's foot trefoil (*Lotus corniculatus*)
Treatment 9: dandelion (*Taraxacum sp.*) + alfalfa (*Medicago sativa*)
Treatment 10: dandelion (*Taraxacum sp.*) + red clover (*Trifolium pratense*)

Test of three cutting strategies (St.1-3)

Harvest			1		2		3		4		5		6		7		8		9					10
week	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
St. 1		x	★	x		x		x	★	x		x		x	★	x		x		x				★
St. 2		x		x	★	x		x		x	★	x		x		x	★	x		x				★
St. 3		x		x		x	★	x		x		x	★	x		x		x	★	x				★

May June July August September



Data collection:
Number of flowers per 0.5x0.5 m

Blanding	Strategi	Parcelnummer	Blanding	Strategi	Parcelnummer	Blanding	Strategi	Parcelnummer	Gent
St-Ko	1	67	St	2	34	St-Ci	3	1	1
Bi-Lu	1	68				Bi-Rk	3	2	1
St	1	69	St-Ko	2	35	Mæ-Kæ	3	3	1
Mæ-Kæ	1	70	St-Ve	2	36	St-Ko	3	4	1
						St-Ve	3	5	1
LU-bi	1	71	Mæ-Kæ	2	37	St	3	6	1
St-Ci	1	72	Mæ-Lu	2	38	Bi-Lu	3	7	1
Bi-Kæ	1	73	St-Ci	2	39				1
Mæ-Rk	1	74	Mæ-Rk	2	40	Mæ-Lu	3	8	1
Bi-Rk	1	75	Bi-Rk	2	41				1
			Bi-Kæ	2	42	Bi-Kæ	3	9	1
Mæ-Lu	1	76	Bi-Lu	2	43	Mæ-Rk	3	10	1
St-Ve	1	77	LU-bi	2	44	LU-bi	3	11	1
St-Ko	3	78	Bi-Rk	1	45				2
			St	1	46	Mæ-Kæ	2	12	2
St-Ve	3	79	Mæ-Rk	1	47	St-Ko	2	13	2
Mæ-Lu	3	80	Mæ-Kæ	1	48	Bi-Rk	2	14	2
			Bi-Kæ	1	49	St-Ci	2	15	2
Mæ-Rk	3	81	St-Ve	1	50	Mæ-Lu	2	16	2
M-Kæ	3	82				Bi-Lu	2	17	2
Bi-Lu	3	83	LU-bi	1	51	LU-bi	2	18	2
LU-bi	3	84	St-Ko	1	52	St-Ve	2	19	2
St-Ci	3	85	St-Ci	1	53				2
St	3	86				Bi-Kæ	2	20	2
Bi-Rk	3	87	Bi-Lu	1	54	Mæ-Rk	2	21	2
Bi-Kæ	3	88	Mæ-Lu	1	55	St	2	22	2
LU-bi	2	89				Bi-Rk	3	23	3
St-Ci	2	90	Mæ-Lu	1	56	St-Ko	3	24	3
St-Ve	2	91	Bi-Lu	1	57	Mæ-Kæ	3	25	3
St	2	92	St-Ko	1	58	St-Ve	3	26	3
Bi-Rk	2	93	LU-bi	1	59	St	3	27	3
Bi-Lu	2	94	Mæ-Rk	1	60				3
Mæ-Kæ	2	95	St	1	61	Mæ-Lu	3	28	3
			St-Ci	1	62	LU-bi	3	29	3
Mæ-Rk	2	96	St-Ve	1	63	Bi-Lu	3	30	3
Mæ-Lu	2	97				St-Ci	3	31	3
St-Ko	2	98	Bi-Kæ	1	64	Bi-Kæ	3	32	3
Bi-Kæ	2	99	Bi-Rk	1	65				3
			Mæ-Kæ	1	66	Mæ-Rk	3	33	3

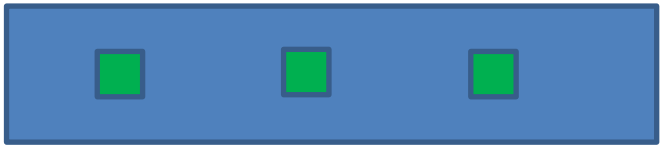
Floral resources and pollinators

Treatment 1: Standard mix (=ryegrass (*Lolium perenne*),
red clover (*Trifolium pratense*) and white clover (*T. repens*)
Treatment 2: All species
Treatment 3: common chicory (*Cichorium intybus*)
Treatment 4: bird's foot trefoil (*Lotus corniculatus*)
Treatment 5: field scabious (*Knautia arvensis*)
Treatment 6: dandelion (*Taraxacum sp.*)
Treatment 7: phacelia (*Phacelia tanacetifolium*)
Treatment 8: ribwort plantain (*Plantago lanceolatum*)
Treatment 9: cumin (*Cuminum cyminum*)
Treatment 10: salad burnet (*Sanguisorba minor*)
Treatment 11: common yarrow (*Achillea millefolium*)
Treatment 12: chive (*Allium schoenoprasum*)
Treatment 13: red clover (*Trifolium pretense*)
Treatment 14: sainfoin/esparcet (*Onobrychis viciifolia*)

Test of two cutting strategies (St.1 and 2)

Harvest			1		2		3		4		5		6		7		8		9					10
week	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
St. 1		x		x	★	x		x		x	★	x		x		x	★	x		x				★
St. 2		x		x		x		x		x		x		x		x		x		x				★

May | June | July | August | September



Data collection:
Number of flowers per 0.5x0.5 m
Number of flower-visiting insects in 5 min.

Conservation and management

Take pollinators into consideration in:

- 1. Agricultural practice
- 2. Nature plans
- 3. National parks
- 4. Planning landscape management

Thanks