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Ecological Evaluation of Recently Completed Restoration Schemes on the River Wensum, Norfolk

Ian Morrissey

RRC Conference 2012, Nottingham

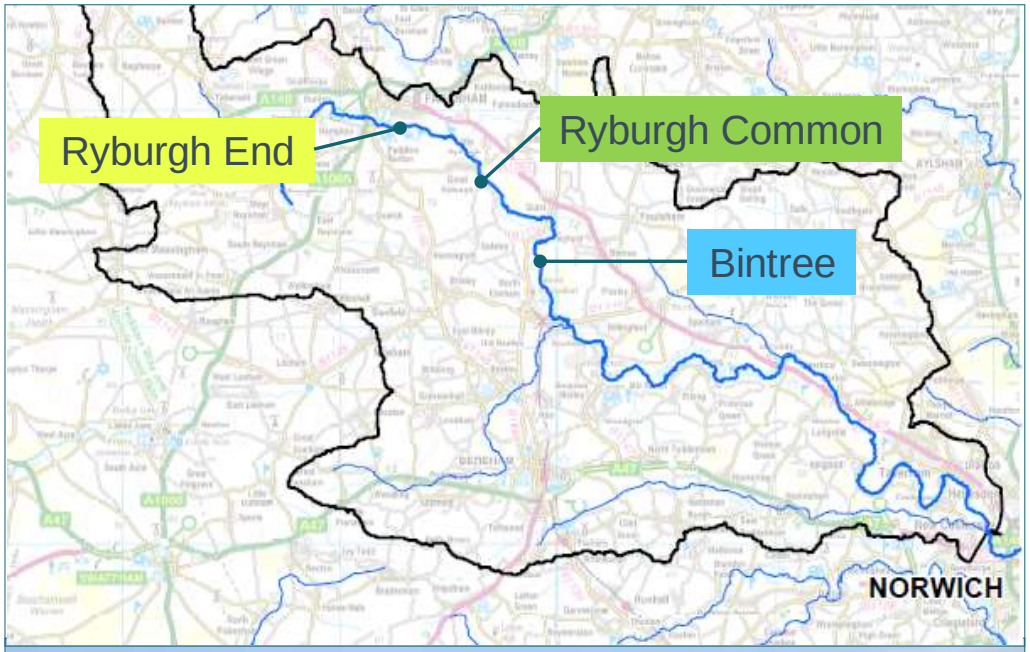
Plan Design Enable

Background

River Wensum Restoration Strategy (RWRS)

- Developed by NE in partnership with the EA, WMA
- River Wensum SSSI & SAC river
  - PSA targets to address reasons for poor condition of the SSSI
  - Water body WFD objectives to meet good ecological potential
- Feasibility assessments
  - Atkins commissioned to progress strategy through production of Feasibility Reports – 71 km of river
  - Provide conceptual designs / costs and environmental scoping
- Detailed design and implementation of schemes

Restoration projects



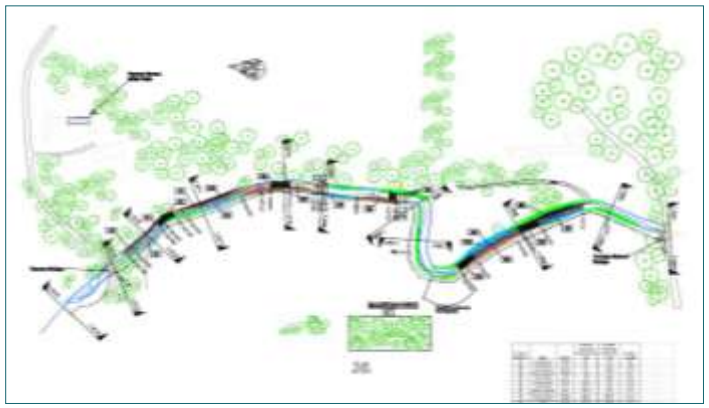
The Wensum schemes

- Three major schemes now complete
  - Bintree
  - Ryburgh Common
  - Ryburgh End
- Other small scale targeted works
  - LWD treatments
  - Bank protection
  - Breach control
- Detailed designs under way for 2 more reaches upstream of Fakenham

The schemes

Bintree (2009)

- Length of river restored: 700 m
- Materials used:
  - 2,320 tonnes of gravel
  - 80 tonnes of crush material for access
  - 1,432 hardwood stakes
  - 1,839 m^2 of geo-textiles (majority coir based)
- Construction period: 11 weeks from 28/09/09
- Project cost: £200,000



Ryburgh Common (2010)

- Length of river restored: 600 m
- Length of new channel: 350 m main river + 100 m IDB drain
- Materials used:
  - 370 tonnes of gravel
  - 77 tonnes of crush material for access track
  - Wood for LWD sourced on site
- Construction period: 8 weeks from 04/10/10
- Project cost: £140,000

The schemes

Ryburgh End (2011)

- Length of river restored: 1,320 m
- Full realignment of flow
- Materials used:
  - 310 tonnes of gravel
  - Recycled gravel
- Construction period: 14 weeks from 15/08/11
- Project Cost: £110,000

Monitoring to date

- All sites pre-restoration monitoring
- Bintree & Ryburgh Common post-restoration monitoring
  - Approximately 1 year after scheme implementation
  - Timing of surveys consistent

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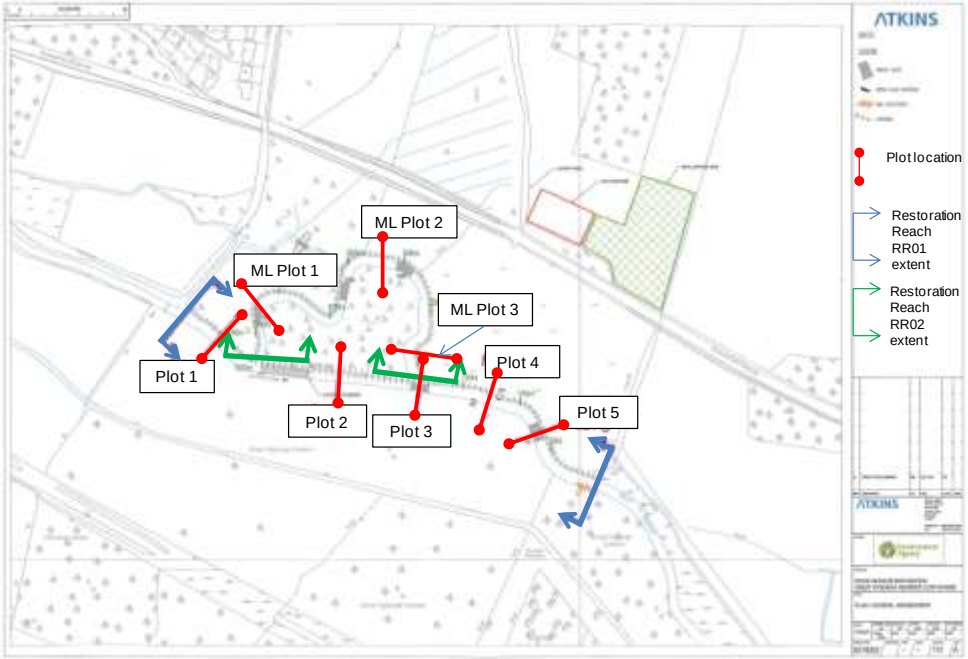
Why monitor

Why monitor?

- Evaluate ecological and hydro-morphological response of the system
- Approach must reduce inherent uncertainty in assessment of success
  - Clearly define objectives of the scheme / scheme elements
  - Understand expected scale of response
- Include a set of measurable hypotheses to underpin monitoring protocols

Monitoring approach

- Cost effective
  - 2 staff, maximum of 2 days on site, plus reporting time
- Repeatable and transferable between restoration schemes on the Wensum.....and to other catchments?
- Use of recognised ecological procedures
  - Common standards for monitoring *Ranunculion fluitantis* and *Callitricho-Batrachion* target communities
  - EA standards for macroinvertebrate and fish sampling and quantification
- Spatial scale appropriate to restoration measures used and expected ecological response
  - Functional habitat approach
  - Restoration reach
  - Plot scale (10 m)
  - Adaptable
- Use of control sites
  - Not always possible
  - To assess ecological trends
- Physical habitat data



Monitored elements

Ecology

- Aquatic macrophytes
  - Visual and grapnel sampling
  - Percent Cover Value
- Benthic macroinvertebrates
  - 3 minute kick / sweep with hand search
  - Bank side identification
- Fish
  - Catch depletion electric-fishing
- Other ecological observations

Physical habitat

- Sediment and flow character
- Channel geometry
- Management class
- Riparian character

Other

- Fixed point photography

Ecological evaluation

Macrophytes

- Focus on changes in target chalk stream species
  - Pre and post-restoration comparative analysis at restoration reach and plot scale
  - Percent cover change
  - Mean Flow Rank scores used to provide indication of community response to flow
- Plot scale response variable depending on measure – disturbance level
  - Plot scale narrowing versus bed raising
- Changes in macrophyte assemblage only evident at a plot scale
- *Ranunculus* colonisation observed

Macroinvertebrates

- Focus on community level response at a plot scale
- Pre and post-restoration comparative analysis undertaken
  - Species list and abundance class
  - Biological metrics
    - Standard indices of biological water quality
    - LIFE (Family): assess response to change in flow
    - PSI review sedimentation rates
  - Rapid colonisation following disturbance or reinstatement of flow
    - Numerous factors controlling
    - Initial results treated with caution
      - » Community persistence

River	River Ilkenum
Site	Great Ryburgh
Survey #	IPM
Survey date	15th / 16th September 2011

		Plot 1	Plot 2	Plot 4	Plot 5
		TF93385 28196	TF93786 29170	TF93822 29153	TF93867 29109
Family name	Genus species				
Hydrobiidae	Potamopyrgus antipodarum	D	B	D	D
Lymnaeidae	Radix baltica (peregra)	A		A	
Physidae	Physa fontinalis	B	B		
Sphaeriidae	Pisidium				B
	Sphaerium	B	A		
Ancylidae	Ancylus fluviatilis			A	A
Oligochaeta	Tubificidae	B	A	B	B
Glossiphoniidae	Glossiphonia complanata				A
	Helobdella stagnalis				
Astacidae	Austropotamobius pallipes	A	A		
Asellidae	Asellus aquaticus			A	
Gammaridae	Gammarus pulex	B	B	A	C
Caenidae		A		A	A
Baetidae	Baetis spp	B		B	C
Ephemeridae	Ephemera				A
Ephemerellidae	Serratella ignita	A		A	A
Leuctridae					A
Calopterygidae (=Agriidae)	Calopteryx	A	A		
Gerridae			A		
Corixidae	(adult)	A			
	(juvenile)		A		A
Micronectidae	Micronecta poweri		B		A
Haliplidae	Haliplus (larvae)			B	B
	(adult)				
Dytiscidae (incl. Noteridae)	Potamonectes depressus elegans				
Elmidae	Oulimnius (larvae)	A			
	Elmis aenea (larvae)	B		A	A
	(adult)			A	B
Sialidae	Sialis lutaria				
Hydroptilidae				B	empty cases
Hydropsychidae		A			B
Polycentropodidae		A		A	B
Leptoceridae					A
Goeridae					A
Tipulidae	Dicranota				A
Chironomidae		B	A	B	B
Hydracarinidae		A			A
Daphniidae					
Ostracoda					
Culicidae			A		A
Ceratopogonidae		A			
No. Taxa		19	12	15	24
No. BMWP scoring families		16	10	14	20
BMWP		80	44	68	117
ASPT		5.00	4.40	4.86	5.85
Family LIFE score		6.79	6.38	6.50	7.05
PSI (family level)		38.4	29.4	42.9	53.5

Abundance classes
A = 1 - 9 individuals
B = 10 - 99
C = 100 - 999
D = 1000 - 9999
E = 10 000+

Fish

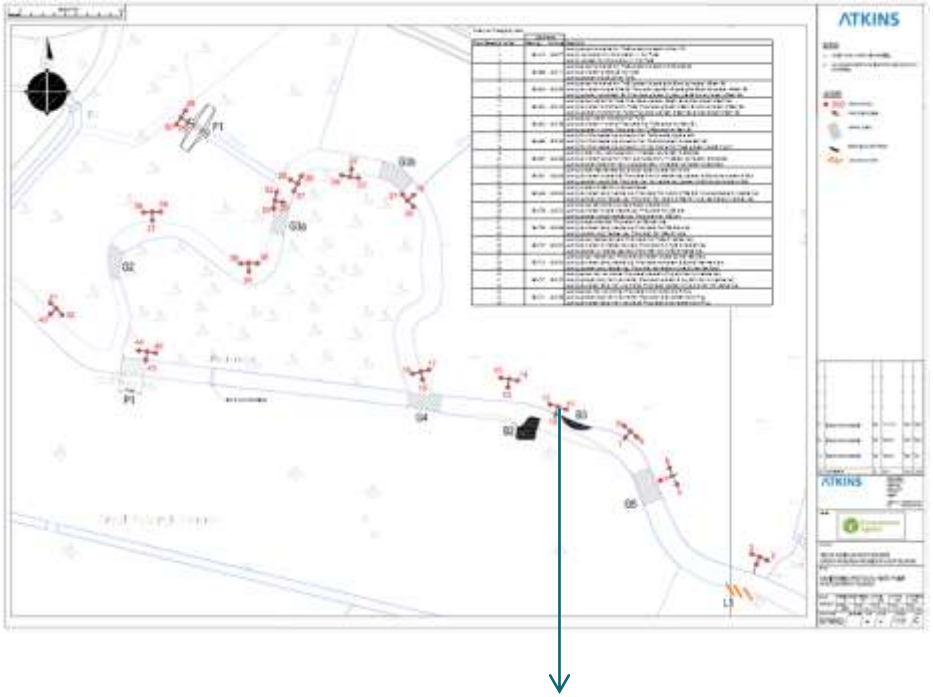
- Reach scale approach
  - Species assemblage and abundance
    - Comparison of density and standing crop estimates
    - Review of target species change

Species	Reach A		Reach B		Reach C	
	Pre-	Post-	Pre-	Post-	Pre-	Post-
10-spined stickleback (*Pungitius pungitius*)						✓
3-spined stickleback (*Gasterosteus aculeatus*)	✓		✓	✓		✓
Brown / sea trout (*Salmo trutta*)				✓		✓
Bullhead (*Cottus gobio*)	✓	✓	✓	✓		✓
Dace (*Leuciscus leuciscus*)	✓		✓	✓		✓
European eels > elvers (*Anguilla anguilla*)	✓			✓		
Gudgeon (*Gobio gobio*)	✓		✓	✓		✓
Lamprey sp. (*Petromyzontidae*)			✓	✓		✓
Minnow (*Phoxinus phoxinus*)	✓	✓	✓	✓		✓
Pike (*Esox lucius*)		✓	✓	✓		✓
Roach (*Rutilus rutilus*)	✓		✓	✓		
Rudd (*Scardinius erythrophthalmus*)						✓
Stone loach (*Barbatula barbatula*)	✓		✓	✓		✓
Total number species	**8**	**3**	**9**	**11**	**n/a**	**11**

Population measure	Reach A		Reach B		Reach C	
	Pre-	Post-	Pre-	Post-	Pre-	Post-
Number of species	8	3	9	11	n/a	11
Standing crop estimate (for fish >99mm) (grams / 100m2)	101.91	77.67	117.53	204.25	n/a	418.24
Density estimate (for fish >99mm) (individuals / 100m2)	1.17	0.17	0.50	1.65	n/a	2.6

Fixed point photography

- Incorporating major features throughout restoration reach
- Provide historical record
- Used to look broadly at rate of change
- Identify any major channel adjustments / shifts in ecological character



11¤	593,924¤	329,143¤	Looking·downstream·of·channel·from·TLHB.·Photo·taken·upstream·of·Berm·B3·and·downstream·of·Berm·B2¤			

How are these data being recorded?

Monitoring reports issued to the EA and other interested parties

- Scheme description
- Aims of scheme and individual measures
- Clearly defined methods
- All locations referenced
- Data recorded in appendices
- Specification of repeat survey dates

Monitoring – have we got it right?

- Require clear objectives to underpin monitoring protocols
  - Or else how do you assess success and inform future design?
- Ecological data collection must be accompanied by physical habitat data
- Scales (spatial)
  - Combination of plot and reach scale assessment is required
  - Dependant on the range and types of measure implemented and ecological element
- Scales (temporal)
  - Long-term monitoring will inform future time scales, monitoring frequency and produce efficiency
  - Early doors – don't panic!!!
  - Pre, 1 year post, then every 2 years.....every 10 year!!
- Beware of potential false positives and false negatives
- Monitoring has informed future design changes
- Flexibility and collaborative working – more detailed assessments
- Manage expectations and monitor behaviour of others

Thank you for listening!!!

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Plan

From cost and risk planning, feasibility studies and logistics, to impact assessments and stakeholder engagement activity, we plan every aspect of our clients' projects.

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Our clients entrust us with the management of projects, people and issues – ensuring that deadlines are met, costs are controlled and success is delivered.

Presentation – Ian Morrissey

Aquatic ecologist working in our multi-disciplinary river restoration team
Focusing on the approach to the ecological monitoring undertaken to date, supporting data collection and some of the techniques that are being used to assess the success of the restoration schemes based on the ecological responses observed to measures implemented.

"Whole river" restoration strategy looking at what actions needs to be implemented at a system scale to improve river condition. This is in contrast to many previous schemes on our rivers which have tended to be piecemeal and opportunistic in nature.
Wensum is chalk stream is designated as SSSI and SAC and the 4th largest of the 26 whole river SSSIs in the country. Primary reason for SAC designation is it Ranunculus assemblages although these occur only sporadically within the river and a number of key species including our native crayfish, brook lamprey and bullhead.
The main driver was the PSA targets to meet favourable condition now WFD requirements
The river SSSI is divided into 9 sections, each subject to a Feasibility and Environmental Scoping Report.
In hindsight.....monitoring requirements should been included.....

As a project team we have been able to secure funds for pre and post restoration monitoring on the 3 major completed schemes. Listed in chronological order of competition
These have to date concentrated on the upper to mid to upper reaches of the Wensum.
Smaller scale projects have been undertaken.

As you can see these are relatively large scales……..

All sites have undergone pre restoration monitoring
Current program me we have completed post-restoration monitoring for Bintree and Ryburgh Common scheme
Timing of surveys is determined in part by the works completion date although all surveys have been undertaken at the same time of year…….back end of the summer / early autumn
Goes without saying the importance of repeat survey timing consistency to ensure validity of any comparative data analysis

Have we achieved our objectives.....these will be scheme specific
These hypotheses will be scheme specific but in terms of the Wensum related to the provision of appropriate habitat to support target species and species assemblages
For example channel narrowing measures were implemented to improve flow velocities to favour target plant communities.
Measuring the response of macroinvertebrate, macrophyte and fish communities to the hydro-morphological change arising from restoration measures has identified where the works have acted positively to increase the extent of target species and assemblages. The use of standard biotic indices obtained from aquatic macrophyte and macroinvertebrate community data in determining the ecological response to instream works is discussed, together with lessons learned from the monitoring programme and follow-up measures implemented in light of the current assessments.

1 day in the field 2 ecologists.....actually not that cheap but provision was made within the project budget
General methodology is the same and can be applied across the catchment
Based on known procedures relevant to chalk schemes this one base on JNCC
Common standards JNCC use of standard sampling practices
Plot location selection was prescriptive to taken areas of channel that had undergone specific changes e.g. Glide installation, berm creation, no change
Adaptable: image shows meander loop reconnection Blue reach indicators pre and post restoration.....following reinstate of flow secondary reach with its own plots.
Use of control sites to see if direction of change in the restored sections is reflected in unaffected channel areas.
Monitoring of physical habitat to assess channel and flow characteristics to help with the interpretation of ecological data

2 days in the field with no sample removal so all macrophytes and macroinvertebrate identification and numeration is undertaken in the field so requires competent ecologist.

Case of the Wensum increase distribution of Ranunculus (water crowfoot) vegetation community type to review broad scale changes in physical habitat character arising from restoration works.

Undertaken at a Plot and Reach scale although initial findings indicate that reach scale is too broad although allows high level review of species assemblage changes and differences in most abundant macrophytes.

Look at alien species

Reach scale assessment procedures were not sensitive enough to be used to assess changes in ta

Not so interested in individual species more a community level response to the works
Look at changes in biological metrics that relate to changes in physical habitat condition that arise from the works: in this instance gravel glides to raise bed and berms to increase local flow velocities the success might be reflected in increasing life score.....

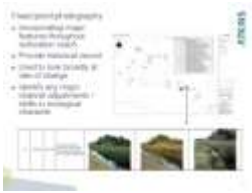
Long term performance of glides PSI to look at whether gravel glide features develop sedimentation issues

The PSI (Proportion of Sediment-sensitive Invertebrates) is a new index designed to describe the degree to which riverine sites are impacted by sediment.

Biotic – life history strategies, species mobility, rate of and type of vegetation establishment

Inter and intra-specific competition and all this runs alongside an adjusting geomorphology and changing plant community.....important that monitoring is continued beyond first year of installation.

Due to transient nature of fish assessments have been undertaken at a reach scale



As can be seen on the photograph sequence for berm .....shows establishment of vegetation after 1 year.....use of sods at berm edge.....forget about the need for geotextiles on bank slopes as establishment is rapid.

Schemes the size of those on the Wensum Plot and Reach scale

Future designs : we expected 500mm of bed raising with gravels to smother out undesirable communities.....time will tell if Spargainum emersum becomes established grown up through the gravel bed...

At this stage not sure about response.....if it had colonised naturally we may have concluded that had not achieved flow velocity aims.....

But now removal of bed prior to gravel placement....

False positives : relates to use of community metrics such as LIFE and PSI which may reflect Agency have been excellent at tagging on additional fish surveys to their routine monitoring.....leads to cost savings