The Value of Phased, Experimental Approaches for Restoration: Lessons from So Cal to Central Asia

Sean Anderson
Environmental Science and Resource Management Program
California State University Channel Islands
salt marsh restoration
coastal Southern California

challenges:
• no interest in restoration
• toxicity (heavy metals)

key metrics:
• tissue, soil metals
• vegetative growth, diversity

phased approach:
• expanding spatial, temporal scales
• address agency concerns at each stage
## Sludge Contamination

<table>
<thead>
<tr>
<th>Element</th>
<th>Mugu Sludge Average (±SD)</th>
<th>Municipal Sludge Average (Range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cd</td>
<td>38 (±22)</td>
<td>16 (3 to 3,410)</td>
</tr>
<tr>
<td>Pb</td>
<td>111 (±107)</td>
<td>500 (13 to 19,730)</td>
</tr>
<tr>
<td>Mo</td>
<td>70 (±54)</td>
<td>30 (5 to 39)</td>
</tr>
<tr>
<td>Zn</td>
<td>1,176 (±912)</td>
<td>1,740 (101 to 27,800)</td>
</tr>
</tbody>
</table>
advantages of sewage sludge:

• restored habitat
• nutrient source
• no sewage disposal costs
• no impacts of disposal

disadvantages of sewage sludge:

• on-site toxicity
• metal migration off-site
## Phased Restoration at Mugu

<table>
<thead>
<tr>
<th>Phase</th>
<th>Exps</th>
<th>Plants</th>
<th>Duration</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>1</td>
<td>280</td>
<td>15 mo</td>
<td>pot</td>
</tr>
<tr>
<td>II</td>
<td>7</td>
<td>~10,000</td>
<td>2 yrs</td>
<td>1 ha</td>
</tr>
<tr>
<td>III</td>
<td>1</td>
<td>recruits</td>
<td>3 yrs</td>
<td>5 ha</td>
</tr>
<tr>
<td>IV</td>
<td>0</td>
<td>recruits</td>
<td>10 yrs</td>
<td>~40 ha</td>
</tr>
</tbody>
</table>
Phase 1: Pot Experiment
Salicornia Growth

Dry Site

Wet Site

dry weight (g)

0% sludge
10% sludge
30% sludge
50% sludge
70% sludge
wetland
wetland (no pot)
Phase 2: Pilot Experiment
Pilot Restoration
Fall 1999

Cover (%)

Salicornia

Frankenia

Monantho

Sludge concentration (%)

0 25 50 75 wetland

clay matrix upland matrix wetland soil
Phase 4: full restoration
grassland restoration
San Francisco Bay Area

challenges:
• endangered species
• invasive species

key metrics:
• soil seed banks
• recruitment rates

phased approach:
• expanding spatial, temporal scales
• *parameterize HCP / conservation agreements*
scaling up tarps

meter² → 100s meter² → hectares

• efficacy

• logistics

• cost (37¢ vs. 0.04¢ sq. ft.)
pre-mowing from yellow to blue
mowed
tarped
steppe wetland restoration
eastern Turkey

challenges:
- ecological collapse
- no capacity / resources

key metrics:
- plant biomass, diversity
- bird abundance, breeding

phased approach:
- expanding spatial scales
- demonstrate principles, ecosystem services
California

land = 403,931 km²  
(4% of USA)

38 million  
90 km⁻²  
87%  
98%  
55%

population (#)  
population (density)  
coastal population  
urban population  
protected land (IUCN I-V)

Turkey

land = 774,820 km²  
(8% of USA)

77 million (25% of USA)  
92 km⁻²  
58%  
82%  
0.7%

Turkish restoration challenges

1) No ecological restoration has ever been done.
2) Naïve/nascent conservation efforts.
3) Massively degraded/overexploited system.
4) High poverty, subsistence agriculture & herding.
restoration efforts in Turkey

1) evaluation
   - document extent of degradation
   - develop indicators of ecological function
   - metrics need be associated with tangible values & sustainable development

2) restoration
   - phased experiments
   - increasing complexity
vanishing communities
few practical restoration skills
existing wetlands heavily degraded
bird migrations key remnant component

2188 birds, 85 spp. ringed to date
309 spp. from region (Kuyucuk = 191 spp.)
initial restoration goals

proximate (1-2 years)

1) boost plant density & diversity
2) boost plant cover & height
3) demonstrate magnitude of current impacts

ultimate (2-4 years)

4) greater bird density, diversity, breeding & residency
5) greater arthropod diversity & productivity
6) greater herpetological density & breeding
7) opportunities to experience nature
performance metrics

1) recruitment (birds, vertebrates)

2) productivity (inverts, plants)

3) community composition
restoration experiments

$\text{meter}^2 \rightarrow 100s \text{ meter}^2 \rightarrow \text{hectares}$

Phase I: Kafkas Seasonal Wet Meadow Grazer Exclusion
began Spring 2007, expanded Spring 2008

Phase II: Kuyucuk Lake Wetland Fringe Grazer Exclusion
began Spring 2008, reinitiated & expanded Spring 2009

Phase III: Kuyucuk Lake Island Creation / Road Removal
Spring 2009

Phase IV: Extensive Grazer Exclusion
pre-restoration conditions
Kafkas Wetland Exclosures

2008

plant cover (prop.)

plant height (cm)

plant richness

plant richness

* * 

graze no graze

* 

p < 0.001

bars: mean ± 1 SE

plant richness

wetland plant richness

April 2007

Sept 2007

cage controls

bank crest

bank bottom

Juncus stand
aboveground plant biomass (g • 0.25 m$^{-2}$)

$p < 0.001$

bars: mean ± 1 SE; estimates assume Kars grazing lands = 7,000 km$^2$

Kars livestock consume:

• ~ 93% (± 1%) of the NPP of the region
• 192 million metric tons of biomass annually (~ 92,000 Gen. Sherman Trees)
• biggest single restoration hurdle?

overgrazing
3 steps forward, 2 steps back

October 2008 Kuyucuk Lake, Turkey
restoration results to date

1. currently in Phase II(b)/III of our restoration experiments

2. large buy-in to our approach high in government, still working on villager & student buy-in, increasing the small but committed Turkish conservation practitioners

3. experiments informing subsequent work
   1. design
   2. response of vegetation
   3. response of small mammals and birds

4. Whitley Gold Award, Kuyucuk Ramsar site, EDEN Award
Dr. Sean Anderson’s
Ecological Restoration Lab

Welcome!

In these here webpages you will find an ever-growing selection of my research and teaching efforts. My colleagues, students, and I tackle a variety of topics related to the conservation of our biological heritage based out of my lab here at CSU Channel Islands. While the majority of my past and current work is centered here in coastal California, I do also have several fantastic long-term research and teaching projects across the United States and our planet.

Please be advised that the large volume of e-mail I typically receive and the fact that I am frequently in the field conspire to make my replies to e-mails often tardy. If you wish to contact me, a phone call is often more likely to get a prompt reply. Welcome and please have a look!

Click HERE for Dr. Anderson’s contact info

Dr. Sean Anderson
faculty.csuci.edu/sean.anderson/
sean.anderson@csuci.edu

(805) 732-2732
ESRM Program   CSU Channel Islands

Current Projects

Ecological Restoration
- Ormond Beach Restoration
- Indicators of Coastal Salt Marsh Functioning
- Colleagues Creek and Riparian Restoration
- Woodlands Trail and Park Monitoring (Lafayette, LA)
- Florida Everglades Wetland Restoration (Florida)
- Ecologists Meet Environmental Sustainability Survey
- New York State Highbush Blueberry Growth Monitoring
- New Zealand Coastal Marine Monitoring
- Woodlands Trail and Park Monitoring (Louisiana)
- California Coastal Inland Marine Survey

Historical Ecology
- California Mountain Lion Home Range Study
- Fire Ecology of Woodland Management
- Seasonal Patterns and Impacts in California Coastal Inland Marine Survey

Habitat Fragmentation
- Ventura County Road Kill Survey

Most of my formal training is in marine population biology, coastal ecology, and the management of coastal communities and their associated biological resources. Over the past few years my research has migrated shoreward and upland, shifting somewhat to emphasize the design, practice, and assessment of ecological restoration projects. While I have worked in a variety of subtidal, intertidal, and terrestrial systems, my current work emphasizes coastal systems (particularly coastal salt marsh and coastal riparian systems) and ways to improve their...