Pitcher's thistle in Indiana: Is it viable and if not what needs to be done?

October 17, 2011

Indiana Dunes State Park Nature Center

Introductions by Bob Daum and Brad Baumgardener
Organized by Noel Pavlovic and A. Kathryn McEachern

Workshop Goals

-Information update: what do we know about pitcher's thistle ecology and genetics?
-Review pitcher's thistle status and trends in Indiana
-Develop management options for Pitcher's Thistle in Indiana

Highlights of Meeting
Management Actions

- **Control goldfinch predation**
- **ID potential planting areas**
- **ID threats**
- **Reduce visitor trampling**
- **Get funding**
- **Establish a nursery**

Timeframe

- **Plan for 10 years—establish a 2, 5, and 10 year plan**
- **Monitor and implement adaptive management**
- **Get bagging this summer (2012) to start nursery**
- **Prioritize restoration sites**
- **Get funding**
- **Keep track of what we have done so we have records**

Federal recovery plan objectives in relation to Indiana
Noel Pavlovic (USGS)

Life History: Short lived monocarpic herb. seedling→juvenile→adult→seed

- Seedling: cotyledons, seedings (cotyledons shrivel) – first year
- Juvenile: grows 5-8 years, as a rosette
- Adult: Flowers 1 time, then dies-- has to survive as a juvenile for a long time to flower
-seeds can germinate first or second year

-when seeds get moist – become mucilaginous, possible long distance dispersal mechanism.

Habitat: Western Great Lakes; most along Lake Michigan in Michigan shores, few in Wisconsin, IL, IN, and Ontario
50% open sand = ideal
4 landscapes on dunes shorelines

1. Simple linear beach foredunes: Lake level dunes, continuous but susceptible to loss when lake level rises
2. Discontinuous dune complexes: isolated blowouts - non-continuous
3. Continuous perched dunes complexes: these are further north, e.g. Sleeping Bear, have the best habitat, and are large continuous landscapes
4. Continuous dune complexes: large extensive and wide landscapes mostly at lake level

Metapopulation Dynamics – dynamics in landscape where populations shift
Prediction: Pitcher's thistle habitat will change with climate change (will shift further north)

Photograph of intact central dunes (Dune Park) @ INDU – a lot of bare sand – blowouts formed in 1800's and have been filling in with grasses since then

Factors in Dune Formation & pitcher's thistle habitat

- Future of blowouts is important! – need open sand and decreased littoral drift may prevent tall blowouts from forming
- Climate change→to lake level change
- Change in sand supply
- Storm events
- Human impacts
- Biotic variation
- Predation (goldfinch)

Since1999 Lake Michigan levels have decreased, and new dunes and foredunes have developed. From 1972-2005 – blowouts have filled in with trees, especially at Ogden Dunes.

Miller – sand buildup because of revetment in the west. New dune ridges are forming and are dominated by Marram grass – and most recently by Cottonwood. Pitcher's thistle is only in two blowouts far away from the lake.

Federal Recovery Plan

- 1988 – Recovery team formed
- 1992 – Plan completed
- 2001 – FWS revision
- 2002 – completed plan

Section 6 Gives states money to monitor
Section 7 Federal Agencies need to evaluate actions
Section 10 Authorizes FWS to issue permits

Recovery Goals:

- Restore populations in select sites: within 2 historical sites (in IL, IN or WI), because those states had the fewest remaining Pitcher's Thistle
- Conduct research for protection
  Research seed bank and dispersal, flowerhead weevil—bio-control for the musk thistle can decrease seed
- Protect and manage occurrences (through surveys, protect habitat)
- Establish and conduct surveys (map pops)
- Inform the public (develop and distribute info), communicate with user groups (ORV, sand-mining)
- Implement and monitor management plans for all publicly owned occurrences
- Study non-native weed invasion and determine degree of threat—spotted knapweed= potential threat/host of weevil

Other threats

- Human tramping, collection
- Weevil
- Decreased lake levels
- Decreased blowouts

Occurrences have been measured in Indiana – 13 populations have been ranked. No patches right on coast-all offshore a bit, and were mapped in 2003. Habitats are on blowouts, very isolated, fragmented because of habitat.

West Unit

- Ogden Dunes
  Patches disappeared as trees invaded the blowouts; are left behind in blowouts
- West Beach
  West Beach populations on west have numerous volunteer trails, but east of the road, populations are protected and there are more plants (the succession trail was a success!)
- Miller
  Population is 0.6 miles inland of the Lake
  Jack pines are getting taller and isolating patches from wind

East Unit

- Dune Acres East/Howes Prairie
- Porter Beach- new occurrence discovered by John Ervin around 2008 and additional plants discovered by Sue Lehmann on Bote Drive.
- Keiser Blowout (Kemil)
  small populations-succession is occurring
- Furnessville/State Park
- Dunes Acres "one of a few occurrences on shoreline"
  Large population on southwest facing slope
  Big blowout Interior populations 1990-2008 – 75% reduction in pitcher's thistle

Nearshore 1990-2008 – 60% reduction in pitcher's thistle

Questions
Are restorations populations considered element occurrences or as recognized protected populations? Yes according to USFWS East Lansing office
If the population declines, what legal actions are management agencies required? None
Who decides to let an occurrence become locally extirpated? Management agency has discretion

Artichoke example (specimens brought by Kathryn McEachern from California)

- outside = involucral bracts
- inside = receptacle
- when seeds are forming, gold finch try to break through the outside bracts to get to the seeds (this is happening A LOT)

Population trends of Pitcher's thistle in Indiana and the regional threats to its viability at 3 native and 2 recovery sites
Kathryn McEachern-Research Plant Ecologist at Channel Islands NP

- Look at pitcher's thistle and it's direct relation to dune formation and changes
- When pitcher's thistle is managed, have to manage the whole system—from sand processes on up—think broadly
- What can we do at our level-at population level
- What we need are small populations that are producing seed to re-colonize new areas of open sand
- Litter build-up and root zone competition are effecting new seedling and juvenile pitcher's thistle

Methods: We (Kathryn and Noel) establish plots at 3 spots in INDU for demographic monitoring in 1988

- Miller Woods, West Beach, Big Blowout
  West Beach=high visitor use site, Miller Woods=low visitor use, Big blowout=low/med use
- In Portage Lake Front Park, two restoration sites, planted seeds from Howes Prairie, Big Blowout and West Beach, and set up demography plots
- Annually looked for seedlings, flagged every other plant in population; measured root crown diameter
- Data allows us look at the long term- how are the populations doing?
- Take distance and azimuth from conduit to find same plants each year
- Count the number of flower heads (can estimate how many seeds it could produce)
- Also monitor sand movement (wood posts)

Trends

- Since 1988-the trend has been decreased juvenile and flowering plants

- Variability like this is not uncommon-characteristic of Pitcher's Thistle
- Seedlings in plots were also variable

Restored Sites:

- Ogden Dunes East (dominated by marram grass)
- Ogden Dunes West (dominated by little bluestem)
- Small percentage of the population (7-10%) were flowering plants; most of the population made up of juvenile plants
- Good seedling years are immediately followed by upward trends in populations with juveniles
- But between seedling flushes, trend goes down.
- Seedlings per adult: 4-5 seedlings/adult=average

Plants have to survive as a juvenile for a while…why this is a problems

- Insect mining—insects oviposit larvae in root crown, resulting in premature death or damage
- Trampling by humans

Adult vigor-habitat quality

- Quite often seed heads at big blowouts are less dense – why? Low vigor
- Higher vigor plants were where sand is moving slowly – they can do well where sand builds up slowly – but cannot handle just a few centimeters of erosion

Drought

- 2005-severe drought for many years led to adults that weren't making seeds and there was no revitalization. No seed produced for few years can wipe out a population.

Goldfinch feeding – appears to be increasing at INDU, maybe because trees are closer where birds hang out. Another possibility is that there are more goldfishes. Lately almost every plant is 95% eaten.

Rabbit grazing - Particular in Ogden Dunes and West Beach. Plants survive long juvenile stage, and then rabbits eat the adults!

Insects lay eggs at base of flower – larvae eat out base of head and prevent seeds from forming or from even flowering

Rhinocyllus conicus = Bio-control weevil for musk thistle that is negatively impacting pitcher's thistle. In greenhouse tests – weevil decreased population growth by 15% per year and the time to populate.

Seed viability – numerous factors effect seeds: insects/drought/inbreeding

Need to take action

Currently populations are: few, small, isolated, declining

Constraints on the population = trails, traffic, control, sand management, mixed plantings, rabbits, pesticides, weevils
Target populations are: many, large, connected, and growing

-West Beach succession trail: keeping visitors on the trail worked, 6-fold increase in plants in years following
-Netting over seed heads to keep goldfinches out
-How far could a goldfinch carry a seed? Most is probably destroyed thru digestion

Pollinators of pitcher's thistle are many different flying insects—not specific

Bird Question – in the breeding bird counts, is there an increase goldfinch? Could this be related to increase in bird feeders?
3% increase in goldfinch over last few decades in Michigan and Wisconsin

Plants easily grown without inoculum

Demographic projections for Indiana sites compared to other sites
Dr. Tim Bell – Chicago State University

Followed individual plants throughout their lifetime, measure vital rates (Growth, survival, fecundity) at:

- Illinois beach – 2011-1991
- Indiana sites – 1988-2011
- Wilderness State Park, Michigan -- 1995-2011
- (another restoration site in Kenosha, Wisconsin)

Population viability analysis (PVA) -find out if a population will persist into the future

	seeding = g + s	g=growth (move into next stage)
	to	s=survival
F=	juvenile – g+s	f=fecundity
	to	
	adult	

Things PVA can tell us:
Project next year's population, how long a population will exist (time to extinction), Growth rate, Elasticities

flowering→seedling (high mortality rate as a seedling as compared to juvenile)→small juvenile→medium juvenile→large juvenile→pre-flowering→flowering

-The bigger the plant, the greater the chance there is for next year's survival
-Is possible to get big after seedling and skip steps or to go backwards and get smaller

Goal

- Use PVA to determine whether populations are viable
- Will populations persist? (Pp) (probability of persistence)
- How long will it persist median time to extinction (MTE)

Know climate and weather change affect pitcher's thistle, but have no way to predict future, so since we cannot predict; build different models on possible weather conditions
Process repeated many times to produce many trajectories for populations

Simulations use data through 2007, and only represent what may happen in the monitored plot—populations move around!
Looked at population in 2007 and graphed average trajectory of population size into years into future

West Beach: trajectory very bad 0- population to drop to 0 in 40 years – average growth rate = .83 (below 1 = not growing)

- Pp=0%
- MTE = 15.4 years
- On average, WB populations will decrease 17% each year
- probability Pp = drops each year

Miller

- Pp = .91%
- Will last 26 years MTE, some probability of persistence to 100 years (.8%)

Big blowout

- Growth rate higher = .91
- Pp = 4.6%
- MTE = 22 years
- Small percentage chance population will persist (this population will decrease 8.6% each year)

Ogden West – Andropogon – restoration sites

- Pp = 0%
- MTE = 8.6 years
- Population will decrease

Ogden Dunes East – Marram grass restoration sites – best population, fairly stable

- Pp = 57%, growth rate = 1.0, stable, but not shrinking
- MTE = 19, population will increase .3% per year , confidence is 0-1%

Wilderness State Park – not doing so well

- Population will decrease 14% per year

Illinois Beach State Park – a restoration site with a really growing population!

- Pp = 100%
- MTE = -----(blank because not forecasted to go extinct)
- population will increase 2.5% per year

Summary of 100 year outputs

Site	Name	λ_s	95% bootstrap CI for λ_s	chance to persist to 100 years	Median time to extinction (years)
WEBE	Indiana Dunes National Lakeshore – West beach	0.8253	(0.7782, 0.8810)	0% (0%, 0%)	15.4 (12,22)
MIHI	Indiana Dunes National Lakeshore – Miller	0.8876	(0.8351, 0.9428)	0.91% (0%, 8.20%	26.4 (18, 42)
SPBB	Indiana Dunes National Lakeshore – Big Blowout	0.9138	(0.8320, 0.9947)	4.59% (0%, 51.80%)	21.6 (10, 47)
ANSC	Indiana Dunes National Lakeshore – Ogden Dunes W	0.6394	(0.5489, 0.7313)	0% (0%, 0%)	8.6 (7,12)
AMBR	Indiana Dunes National Lakeshore – Ogden Dunes E	1.0029	(0.8818, 1.1436)	56.86% (0%, 1%)	19 (10, 100)
WSP	Wilderness State Park	0.8650	(0.8317, 0.9006)	0% (0%, 0%)	22.5 (18, 30)
IBSP	Illinois Beach State Park	1.0245	(1.0060, 1.0383)	100% (100%, 100%)	--

How do threats impact viability?

- Inbreeding – 75% decrease in seed and seeding success
- seed predators – biocontrol weevils decrease seed output by 50%
- goldfinch – consumption reduces seed output by 90%

Looked at probability of extinction with relation to all threats – results grim; with all factors, pitcher's thistle is gone in 5 years

*Currently looking at metapopulation @ INDU—to account for populations out of surveyed area

Ogden Dunes

Little bluestem sites doing worse than marram grass site because dune is more stable (what they expected)

Implication of population genetics to managing Pitcher's thistle

Jeremie Fant- Chicago Botanic Garden

Landscape, gene flow and genetic history:

- genetic diversity is crucial for adaption and evolution
- genetic structure determines sources of available genetic variation

Neutral markers were used to measure genetic diversity

- Provide map of underlying genetic diversity associated with genetic drift
- Migration (mutation rates)
- Assortative mating (inbreeding)
- Phylogenetic history

Endemism – pitcher's thistle is an endemic species

- highly restricted range, fragmented habitat
- strong habitat preference, strong selective advantage of not spreading far

Marilyn Loveless Surveyed Lake Michigan populations

- 2 markers drove allozyme analysis
- found low genetic diversity

Pitcher's thistle – probably a derived species

- separated by glacial retreat
- *Cirsium canascens*= probable mother species
- has significant amount of inbreeding
- lower diversity than other cirsium species (but not significantly so)

Southern range = South Lake Michigan = lower diversity than populations in Northern Lake Michigan (center of range)
Northern range = Canadian populations = extreme inbreeding, low diversity – like INDU

Compared genetic diversity to population size

- Larger populations = larger diversity and vice versa
- Inbreeding not correlated to population size

From southern to northern range, can match up with different markers (SLBE has both) in South, separate populations are very genetically different

Is there an exchange of genetic material between close populations?

Yes @ SLBE
North of range – No genetic exchange between close populations
Indiana- No exchange of genetic material—population is closer in genetics to SLBE than to neighboring populations!

Movement of PT is connected to shoreline

SLBE may have been a historic refugia during glaciation and has shared genetics with northern and southern populations – contains maximum diversity—may be the original population

SLBE, Lake Huron, and Lake Superior = original populations
Other populations spread from these locations
Southern population is most recent

Range wide, isolation causes spatial genetic diversity and diversity is also from post-global movement.

Local level – constant extinction and repopulation leads to a lack of similarity to neighboring populations and loss of diversity

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Lessons learned from *Cirsium pitcheri* restoration (and the restoration paradox)
Marlin Bowles

Illinois Beach

- Pitcher's thistle disappeared in 1920's, why? Human disturbance?
- Ecological study identified suitable shoreline dune habitat

Restoration methods

- Collected seeds from wild in Wisconsin and Indiana
- Moist stratified seeds over winter at Morton Arboretum, spring germinated, field planted in August (1992-1994)
- Direct planting of seeds in field (1993-1994)
- When planted in field – had potting soil (foreign soil). Alternative would be to knock off soil and plant bare root—probably not a good idea. But introducing foreign soil is not either.

Plugs
Greenhouse germination = 77% seeds were
33% survived over winter of outplanted juvenile plants
Flowered in 3-4 years

Seeds planted in field: Planted individual seeds with tweezers just below surface of sand
(Not much success of germination in 2 years)

	1993	1994
# of seeds planted	853	878
Germinated	11	2

Full Season propagation: plants were planted in spring the following year, after overwintering in the greenhouse. Results: almost all flowered the year of planting, due to longer propagation period.

Fall planting had a high mortality and delayed flowering

Restoration Paradox: Overwintered (spring planted) plants were larger and flowered immediately, but have lower seed head production (lower fecundity)

Illinois Beach: From 1991-2011
Natural plants slowly increased in number of individuals surviving
Transplants decreased (planted almost 900, and currently are 100 left)

Three months in cold moist in petri dish: Field germination bad, greenhouse good
Planted 1000 of these seeds in field- less than 1% germination. Something caused the seeds planted in the field to go dormant. We know this because seeds with the same treatment that were planted in the greenhouse had good germination.

Established a nursery in 2001: Plants did well and became giant- individual plants produced 500-1000 seeds. But was this causing a selection for the toughest plants?

Seeds:
- Seed head size is a good predictor of the number of viable seeds. Plants that produce small seed heads usually produce few, but large seeds and vice virsa.
- Average seed dispersal= 1 meter
- Wild plants have lower seed mass and lower seed production that nursery grown plants
- Weevil seed head predation may decrease seed mass and number of seeds

Lessons Learned:
- Restoration of Pitcher's Thistle is not easy!
- Seed germination rates differ between greenhouse and field settings
- An increase in propagation time and increase in propagation size does not lead to an increased fecundity of out planted plants

Need to Know:
- What limits seedling germination and establishment in the field?
- Can low seedling establishment be overcome in restoration?
- What effects will weevils have on seed production and population maintenance?

Afternoon Management Session: Talking points
Facilitated by Bob Daum

1) What are the legal requirements for NPS and IDNR per endangered species?
2) Who should be coordinating activity?
3) What management actions could assist viability of pitchers thistle in Indiana?
4) Where on the landscape should we do various management actions, if any?

Legal Requirements
Section 10 permit- 'Promotion of Species'. Need to have everyone's name who will be active on the list. It takes several months to get back from the regional office. We need to know what we

want to do and who will do it. The Federal and state levels need the same permit. Section 7 is require only if construction is involved.

State DNR …so INDU/State park would need to do both permits

Permit from Joy to work on NPS property

Restored populations are protected- and are considered element occurrences even though an EA hasn't been assigned. FWS doesn't decide to let an occurrence go locally extinct; that is up to local management agencies.

If we made an outdoor nursery- would that be protected?

-Federal agencies are not required/obligated to carry out programs
-A recovery plan is recommended- and the agency will set the policy
-Plants have generally escaped mass extinctions (normally just effect animals)

Section 7 of the ESA: Consultation is done regularly. Conservation (though this virtually never happens). What it takes to de-list a species. Each state should develop a management plan- whether we do nothing or something- will the population change?

No specific requirements after making a recovery plan, and delisting is premature.

Who should be coordinating restoration efforts?
Coordinated workgroup---lead by Vince and Tameka (from East Lansing, MI), since they are the leads for pitcher's thistle from FWS.

-Nature Preserves (IDNR)
-NPS
-State Park
-USGS (Noel)
- Technical advisory group- who may not meet as often with the group, but provide advice and expertise
-Other entities who have populations outside of NPS and State Park in IN
Dune Acres (Barbra/Dune Acres is very interested in cooperating)
USX- just beyond NPS property at Miller.
-Mike Prenskar (MI State)
-Amanda Brushaber- NPS Sleeping Bear DUnes
-Liz M, Ryan O'Connor (WI)
-Several researchers and representatives from all the management agencies.

Management Actions

- Monitor populations to realize threats, focus on defining recovery criteria.
- Monitor seed weevils
- Active management in the arrest of species decline is important

- Manage habitat- knock back succession by cutting trees, we could burn and delay succession), weed management. The question was raised whether increasing fire management would benefit the species especially if the burns were conducted during the dormant season. Plants are probably fire sensitive (will have data about this next year). Fire would remove the thick thatch where marram grass dominates, but marram grass would rapidly regrow, thus making the opening of habitat quite ephemeral and not likely to help.
- Volunteer Trails-we know where the populations are, so let's work on keeping people out. NPS has had success at Mt. Baldy with a thin cable fence.
- Include signs with information for visitors (being sensitive to endangered species locations).
- Keep interpretive staff informed
- Find places on the landscape where pitcher's thistle could exist in early succession areas and protect them from trampling—are the plants not there because of disturbance? Possibly, but seed dispersal is limited.
- Create new populations, using GIS to find good potential habitat
- Protect existing populations first and maximize those areas for success
- There is clear evidence of people and dogs walking in Dune Acres and Ogden Dunes- even just researchers and park staff are effecting the dunes- need to be aware that trying to do good and manage/study the area can affect the erosion of sand around the juveniles and seedlings.
- Establish monitoring protocol
- Summarize assessments of known occurrences (describe current 'winning habitats')

Seeds

- If we are going to collect seeds, where do we collect from?
- Usually stay close to where the plants will be planted, but in the case of rare species, may benefit from going farther. Since pitcher's thistle very randomly establishes new populations, there isn't anything wrong with getting seeds from Sleeping Bear, but may suggest using local seed sources connected with the planting areas. Need to establish seeding populations now- this is vital, while we figure everything else out. Connect local populations thru plantings to increase diversity.
- Bag seedheads to prevent goldfinch predation (may still get damaged by insects). If we don't' know where to plant the seeds, can just poke individual seeds into the ground where they would have naturally fallen.
- Conduct weed management in pitcher's thistle areas, especially spotted knapweed and mush thistle that might harbor the weevil (Larinus .

NPS is working on a Shoreline Management Plan, and pitcher's thistle is included, and when we have a draft of the plan, will want the groups input.

Think about habitat on a long term—the dunes have grown significantly in the last 20-30 years, the fordune has grown up, water is further away, and the foredune blocks wind from the lake. Now have a wide beach and high fordune—may be the worst case scenario? Should be going into higher lake levels in the future—we are trying to change a changing landscape. Plant them on the foredune, and use the foredune as a pathway for plants to travel between blowouts.

Foredune populations may fluctuate with lake level. At Miller Woods and Dune Acres are two big growing beaches without many people or social trails = our best spots to plant?

Keep in focus how we should respond in response to the new geologic phase that is affected by man's actions (or… we caused it, we should work to fix it)

Land surveyors didn't find any blowouts in the early 1800's—but they were charged to document timber and farmable land (so transects may not have gone thru blowout areas?) However, blowouts have ghost trees that have radiocarbon dates around 1800's to modern- they haven't been buried that long. In the 1850's a lot of pines were cut from the dunes, which may have led to the formation of blowouts?

Pitcher's thistle growing along social trails—which came first? Do we know the age of the blowouts (Erin Argylian and Zoran Killabarda are working on that currently?)

Genetic diversity is biggest issue; need to create a habitat where it can travel.

Pitcher's thistle is the icon of a healthy dune system, anything we do to promote this species will help a suite of other organisms.

Questions to be answered

At the State Park, seed has been harvested from the bluff, and planted down on new habitat on foredune, are waiting to see the results next year.

'Research the effect of fire on pitcher's thistle.

Fertilization supplements and does it enhance survivorship of juvenile plants and seed output?

If goldfinch are such an issue, we need to study this issue…The 'gigapan' camera that Justin Borevitz installed Big Blowout is still there, but turned over to the state park since Justin is moving to Australia. Can we focus them in on pitcher's thistle plants? Need to observe the birds.

Band birds within the towns to see if they are the same birds eating pitcher's thistle, and ask residents to not feed birds in winter (to decrease the number of birds overwintering here)?

How to protect juvenile plants is critical.

Fire: could we burn in pitcher's thistle habitat to slow down succession (during dormant season)

- In a late spring Rx fire east of Ogden Dunes, some pitcher's thistle accidentally were burned, and there was some mortality, but most are doing fine. We do not know how the smaller size classes were effected until we sample in 2012. Possibly could pre-burn areas without pitcher's thistle to prepare planting areas, then plant them. Those areas able to burn might be too dense for Pitcher's thistle.

Nursery effect: if we plant a lot of seeds in a group, and keep soil moist, does increased survivorship relate to seed density?

Where should we focus our planting efforts?

Important to prioritize planting sites, due to lack of seed source

- Beach house blowout in State Park- both east and west—has historical disturbance but not much anymore. It is an large landscape where Pitcher's thistle might persist.
- Miller Woods – farther from shoreline, away from trail on dunes. Take advantage of sites at Miller Woods closer to shoreline. We know that foredunes will form.
- Foredunes- connect populations on foredunes to create pathways
- Anywhere east of Kemil?- since that is our easternmost population (there was a small population at Tamarack in 1978): Shoreline erosion is probably too great to viably establish the species.
- Crescent Dune (hard to access) Noel, Liz, and Kathryn visited and found there was very little suitable habitat there.
- Boaters Beach (not many people except boaters)

Starting new populations vs. creating new ones, and where to get seed

- One limit to planting = we don't have much seed—advocates planting as many areas as possible
- Plants are easy to grow (70% germination easy), so we don't need a lot of seed to start a seed enhancement project.
- Make populations more diverse; get seeds from Sleeping Bear
- Seeds for Ogden Dunes plot came from areas within INDU, and had good success
- Mixing within just INDU should be good enough to get our 'lambda' up to 1
- Keep seeds local, they are use to the conditions here. Remain concerned with existing populations, and create new ones. Increase established populations is where efforts should be focused

Where to produce plants

Collect seeds from wild in IN, grow plants outside in a nursery—a giant man-made sandbox

- Nursery grown plants are more likely to be selected for more fit plants
- Still need to protect seeds from being eaten
- Pampered plants will have increased survivorship

To increase seed output:

- make one dense, big area planted with pitcher's thistle (problem is that if weevils get to that populations, it will be devastating), so make several smaller dense populations in outdoor gardens

Collecting seed

Don't overharvest seeds from a native population- there are hardly enough seeds to keep those populations viable

Bagging seed heads

-if done after plant flowers, may prevent goldfinch predation
-need to commit to checking back often before they fall
-they could still get eaten by mice (perhaps tan netting is better than black-harder to see?)
Long term preservation of seed may not be possible due to the seed not keeping for very long, however USDA does keep seeds in a lab in CO

Prioritize possible actions
-Netting seedheads against goldfinch, and researching the birds
-Establish a seed nursery
- from some seeds taken from wild in IN, because we can't get enough seed to start a restoration (would need several thousand seeds)
- outdoor setting- between field and greenhouse—a manmade sandbox where we can control conditions

-Analyze GIS imagery to characterize little bluestem vs. marram grass habitats (but do we really need modeling- can we just go outside and see what we need to see?)
-Create a map with critical habitat
-Assess threats
-Manage threats
-Control visitors- where can we have the biggest impact on preventing visitor caused trampling?
-Research into what type of habitat support higher levels of seed germination (different dune types, proximity to other plants or the lake..)
- Tim has been working looking at topographical elements and germination rates, and has had no significant findings

-Include public information wherever we plant (signs work: piping plover success)
-Get volunteers to help collect seeds?
-Institutionalize this project, but how?
-Monitor all actions
-ID potential habitat for introductions

Timeframe for management options…we are in this for the long haul
Average lifespan of 1 plant = 5 years, and they have been researching this in the dunes for 23 years…
-Restoration will be at least 10 years. Create a 2, 5 and 10 year plan
-ASAP- Set up a local task force
-2012: summer- need to protect seed heads from goldfinch, and figure out what to do with seeds
- June 2012– bag seed heads
- August 2012 – collect seed heads. Even if we just bag the seeds and then put them straight into the ground where they were collected will be a good effort.

-Get funding for additional resources

In-kind resources available to draw upon for management
-USGS will keep coming out to monitor
-Julie Stumph has and may be able to continue to help with demographics?
-NPS can apply for funding
-NPS can run Rx burns to help create good habitat (pre-restoration burns?)

-SHLT and STD would probably help
-Utilize students who need research projects
-GLRI has funding for scientists

Possible funding sources:
-Coastal Program
-NPS (PMIS)
-Flora Richardson Fund
-Christine Deloria (new coastal program coordinator)
-GLRI
-Chicago Wilderness
-Learning Center
-GLISTN
-Chicago Nature
-Joyce and Donnelly Foundation
-Coastal zone agreement (run by nature preserves) It couldn't go into federal lands, but to the state park
The workshop ended promptly at 4 pm. We were quite pleased with the workshop.

Notes prepared by Laura Brennan and Lisa Van Auken.