A Site for Sori: Growing locally adapted ferns from spores for restoration

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rubber rabbitbrush
Idaho fescue
roundleaf alumroot
rock spirea
silvery lupine
silvery lupine
silvery lupine
tailcup lupine
Pacific lupine (desert)
partridgefoot
tall lupine
bigleaf lupine
Cusick's monkeyflower
Davidson's penstemon
low beardtongue
Lewis' mock orange
Engelman spruce
antelope bitterbrush
antelope bitterbrush
wax currant
wax currant
Nootka rose
Wood's rose
gray alder
Saskatoon serviceberry
manzanita
greenleaf manzanita
dwarf birch
ceanothus
snowbrush ceanothus
desert sweet
yellow rabbitbrush (sticky)
yellow rabbitbrush
squirrel tail
sanddune wallflower
sanddune wallflower
common wooly sunflower
Oregon sunshine
rubber rabbitbrush
rubber rabbitbrush
Idaho fescue
roundleaf alumroot
rock spirea
giant chinquapin
red alder
Sitka alder
lakeshore sedge
small floating mannagrass
swordleaf rush
panicled bulrush
rose spirea
rose spirea
oceanspray
oceanspray
western pearly everlasting
California spikenard
milk weed
coyotebrush
common rush
Douglas-fir
dwarf rose
oceanspray
Pacific ninebark
Wood's rose
thimbleberry
goldenrod
rose spirea
needle and thread
thimbleberry
blue elderberry
red elderberry
rose spirea
red huckleberry
antelope bitterbrush
smallwing sedge
whitethorn ceanothus
deerbrush
deerbrush
snowbrush ceanothus
bunchberry dogwood
Pacific dogwood
oceanspray
big deervetch
broadleaf lupine
dwarf rose
blue elderberry
bitter cherry
skunkbrush sumac
blue elderberry
chokecherry
Wood's rose
salmonberry
devilsclub
salal
scabland sagebrush
slender hairgrass
mountain ash
oceanspray
oceanspray
Merten's rush
panicled bulrush
Merten's rush
mountain rush (baltic)
fowl mannagrass
lakeshore sedge
awlfruit sedge
mountain ash
Baltic rush
awlfruit sedge
rose spirea
oceanspray
mexican whorled
milkweed
heartleaf milkweed
showy milkweed
mexican whorled
milkweed
frosted indian
paintbrush
milk weed
currant
currant sp.
thimbleberry
basin wildrye

. . . and no ferns

Pacific northwest restoration needs ferns

Ferns from rhizomes

- In the wild, ferns can be grown from rhizomes or spores.
- Previously, we had subdivided ferns from rhizomes, resulting in approximately four ferns per plant.
- Sword fern harvesting is difficult work- roots run deep in older plants!
- Recovery from the aggressive rhizome splitting process for other species, such as licorice fern, is slow.

Problems with ferns from rhizomes

- Ferns recover slowly, often not sending out new growth until the next season
- High labor = few plants collected = low genetic diversity

If not rhizomes, then spores….

- **Minimally invasive harvesting**
- **Can collect from numerous individuals**
- **Potential to yield a lot of plants.**

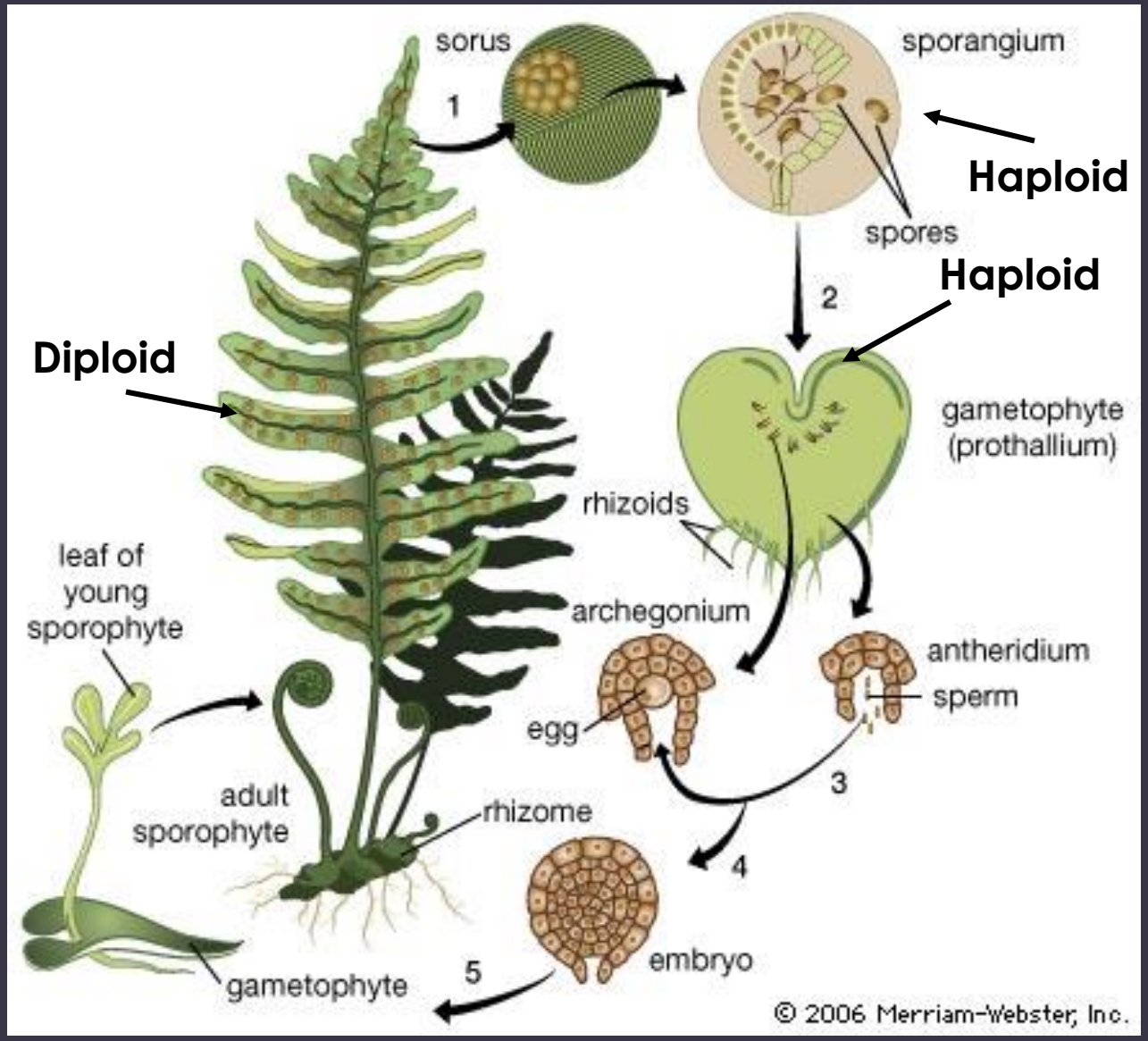
…but spores are difficult!

- Require asceptic conditions
- Two life phases

Fern Physiology

- Spores, gametophyte are haploid
- Gametophyte fertilization produces 2n zygote

- Sporophyte is diploid



Fern Physiology- a two phase life cycle

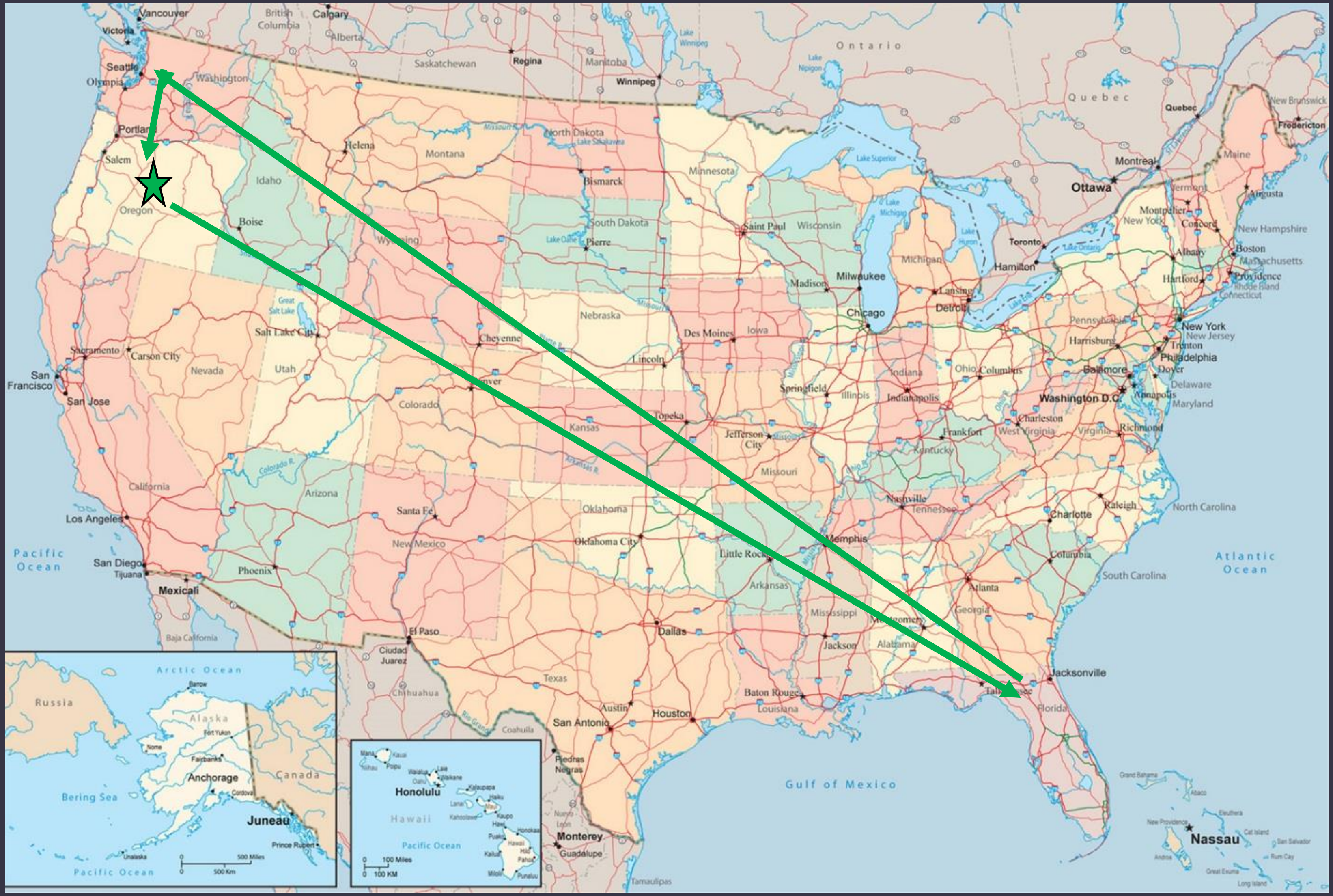
gametophyte: produces sporophyte

Sporophyte: produces spores

Sword fern spores

Licorice fern spores

Contractors were costly…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Olympia
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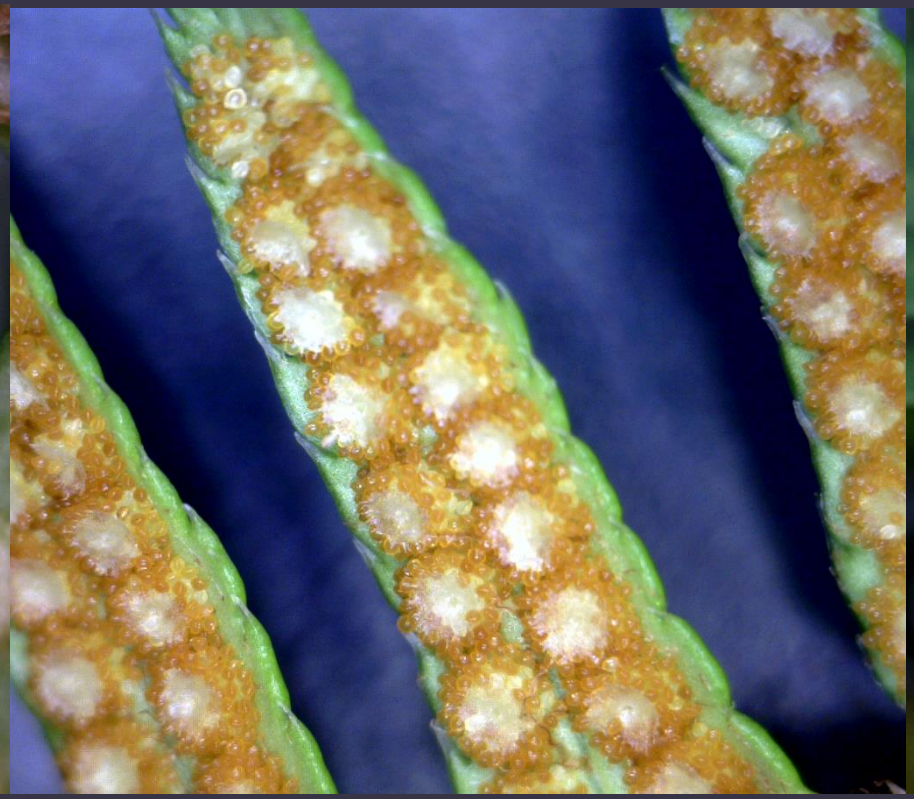
Anchorage
Juneau
Bering Sea
Canada
Hawaii
Honolulu

Our objectives:

- **Collect sword fern spores**
- **Grow gametophyte from spores**
- **Grow sporophytes from gametophytes**

Objective 1: Spore Collection

Sporangium color key indicator for collection
Timing is key: two weeks in the summer
Fronds dried at ~25% relative humidity for one week


Objective 2: Grow gametophyte

- Stringent hygiene requirements in gametophyte phase
- Need water on surface of gametophyte to reproduce

Trial:

- Germination chamber at 100-150 fc, 16 C, 16 hour days
- Substrate: sand, peat, sand + peat, soilless substrate, soilless substrate + sand, q plug trays.

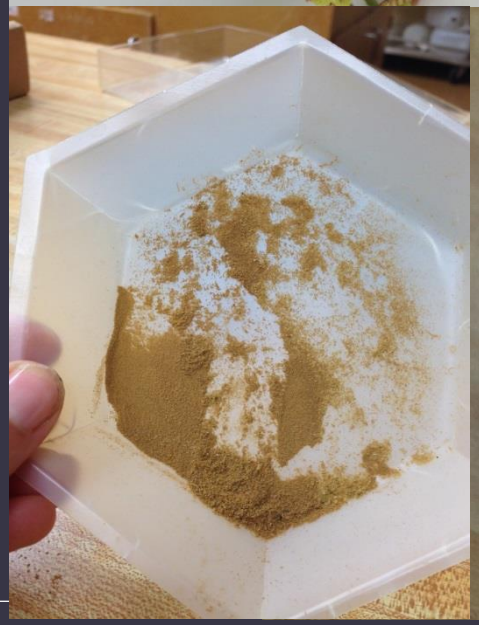
Sanitation

- For substrates: small amounts of media (~500 ml at a time) were placed in glass pyrex with distilled water. Dishes were covered with loose fitting glass lids. Microwaved for 4 minutes.
- Allowed to steam in their containers for another 15 minutes.
- Placed in alcohol cleaned containers.

Q-plug trays

- Q plug trays were washed with hot soapy water, sprayed with alcohol.
- Q plugs had boiling water added 3x's.
- Placed in clear plastic bags & frozen

Substrate	Spore Application technique	Container Used
Sand	1.Sand + spore mix sieved over top. 2. Cotton ball dipped in spores tapped over container	Clear plastic container, glass container, q-plug tray
Peat moss	1.Sand + spore mix sieved over top. 2. Cotton ball dipped in spores tapped over container	Clear plastic container, glass container, q-plug tray
Sand + Peat Moss	1.Sand + spore mix sieved over top. 2. Cottonball dipped in spores tapped over container	Clear plastic container, glass container, q-plug tray
Soilless medium	1.Sand + spore mix sieved over top. 2. Cottonball dipped in spores tapped over container	Clear plastic container, glass container, q-plug tray
Soilless medium + sand	1.Sand + spore mix sieved over top. 2. Cottonball dipped in spores tapped over container	Clear plastic container, glass container, q-plug tray
None	1.Sand + spore mix sieved over top. 2. Cottonball dipped in spores tapped over container	Q-plug tray



A four phase process:

- 1: Germination chamber
- 2. Rooting chamber in sterile conditions
- 3. Rooting chamber in containers
- 4. Greenhouse

Ten weeks later…

At twelve weeks we identified our first gametophyte

Objective 3: gametophytes and some sporophytes (6 weeks after germination)

Sporophyte

When a mat of gametophytes appear on q-plug trays

- Weekly soluble fertilizer of weak fertilizer (33 ppm) with high urea
- Water twice weekly with distilled water
- Rinse soluble fertilizer off leaves with distilled water

When sporophytes appear, move to rooting chamber.

Keep q-plugs in clear bags until sporophytes are present in most plugs, then transplant.

Add time release fertilizer & continue soluble fertilizer weekly.

Spot treat for moss with new bordeux mixture or hydrogen peroxide

Final transplanting

Move to greenhouses in spring.

Transplant to final container size.

Sowing to outplant is about 15 months.

Lessons learned…

1. Hygiene, hygiene, hygiene.

   Alcohol for surfaces, hydrogen peroxide or new bordeux mixture on plants.

2. Understanding the lifecycle helps you predict solutions

Example culturing calendar

- **June 16**: collect spores
- **August 30**: germination occurs
- **September 12**: gametophytes recognizable.
- **October 1**: begin weekly soluble fertilization
- **October 15**: Small sporophytes appear
- **November 1**: Move to rooting chamber (maintain hygeine)
- **December 15**: Keep in rooting chamber, remove bags.
- **January 16**: divide q-plugs, transplant into bark mix. Add time release fertilizer.
- **March** : Move to greenhouse on heat mats
- **June:** Transplant to larger containers
- **October**: Outplant

Where to collect?

Locally, of course!

But what does local mean?

Local plants are best, but what is "local"?

Are there discrete fern populations?

How do ferns disperse, and how does that influence community genetics?

Where should we collect to ensure properly adapted individuals are being grown?

How many plants need to be collected from to ensure we are getting an appropriate survey of fern genetics back on the landscape?

Future for Dorena

- Research needed on breeding zones, diversity, storage
- Fern breeding orchards
- Other ferns species


Questions?