Collecting Weed Samples
for California Department of Food and Agriculture
and the California Conservation Genomics Program

How can I contribute? You can contribute by submitting samples of weeds for genomic sequencing. All six weeds included (Yellow starthistle, Cheatgrass, Field bindweed, Common reed, Artichoke thistle and Italian thistle) have broad ranges in California. We want to see your region well represented. Just collect a leaf or a few flower buds of a target species (2"x2" is sufficient leaf tissue for DNA extraction, but a whole leaf is preferred for identification). Pop your collection in a paper bag or envelope, label it with the specific locality, collector, and date, and mail it to Dean Kelch, CDFA Plant Health, 1220 N St, Sacramento, CA 95814.

An easy and quick way to record your samples is to use iNaturalist (https://www.inaturalist.org/). Download the free iNaturalist application, sign up as an identifier, then join the "Weeds of the CCGP" project. You can photograph each specimen and the field location is automatically recorded. Include your unique field number/identifier in the notes field and write it on the specimen bag. Then, send the specimen to the above address. You can use INaturalist to record records of any species, not just plants. INaturalist's AI algorithm helps you identify species from your survey area and then crowd-sources knowledgeable naturalists to confirm or improve your tentative identifications.

You don't need to make voucher specimens, but if you would like to have a permanent, physical record of the plant you collected, information on how to make a dry plant specimen to deposit in an herbarium can be found at https://www.cdfa.ca.gov/plant/PPD/botany_sampling.html.

What is the California Conservation Genomics Program (CCGP)? The goal of the CCGP is sequencing full genomes for thousands of organisms. We are generating, and making publicly available, full genome sequences for approximately 22,000 individual plants, vertebrates and invertebrate animals representing nearly 150 genera and 230 carefully selected species. We intend to leverage these genomic data to tackle critical biological, management, and conservation issues. We are developing maps to visualize meaningful genomic variation such as climate resilient hotspots and corridors to connect these hotspots. **https://www.ccgproject.org/**

What is the role of the California Department of Food and Agriculture (CDFA) in this? In California, invasive pests cause huge losses both to agricultural production and to the natural environment. Applying the concept of sustainability to invasive species management is a challenging but necessary process, given the increasing rates of invasion and the accompanying cost. The data on invasive species from the CCGP will help us address environmental, social, and economic factors that influence the causes, impacts, and control of invasive species across space and time. **https://www.cdfa.ca.gov/plant/**

For the CCGP, CDFA has chosen 12 invasive species currently spreading or repeatedly introduced in California. There are six weeds and seven insects.

Plants
- Yellow starthistle (*Centaurea solstitialis*)
- Cheatgrass (*Bromus tectorum*)
- Field bindweed (*Convolvulus arvensis*)
- Common reed (*Phragmites australis*)
- Artichoke thistle (*Cynara cardunculus*)\
- Italian thistle (*Carduus pycnocephalus*)

Fruit flies
- Mexican fruit fly (*Anastrepha ludens*)
- Oriental fruit fly (*Bactrocera dorsalis*)
- Mediterranean fruit fly (*Ceratitis capitata*)

Beetles
- Polyphagous Shot Hole Borer (*Euwallacea* sp.)
- Japanese beetle (*Popillia japonica*)

True Bugs
- Asian citrus psyllid (*Diaphorina citri*)
- Glassy-winged Sharpshooter (*Homalodisca vitripennis*)

Asian citrus psyllid
***Diaphorina citri* Kuwayama**
Anticipated genome size: 400-450 Mb
Asian citrus psyllid is native to tropical and subtropical Asia. It was first found in the United States in Florida in 1998. It spread quickly there and three years later was reported in 31 counties in that state. It later spread to Texas, Hawaii, and (in 2008) California, where it is presently established and under quarantine control in the southern portion of the state. It feeds only on plants in the family Rutaceae, especially the genus *Citrus*, and it is a major citrus pest. The feeding of the psyllid on the host plant causes damage, but of even greater significance is the fact that this insect vectors the bacterium *Candidatus* Liberibacter asiaticus, which causes huanglongbing (citrus greening), a disease that kills the infected plant. Huanglongbing has also become established in a small portion of southern California and is also under quarantine. Both Asian citrus psyllid as well as huanglongbing pose a major threat to California's citrus industry.

Canada thistle
***Cirsium arvense* (L.) Scop.**
Anticipated genome size: 1660 Mb

Canada thistle, a rhizomatous perennial herb with prickly leaves, is arguably the worst weed in North America. Plants exist as colonies of basal rosettes until flowering shoots develop at maturity. The flowers are monoecious and smaller than most thistle flower heads. Most plants are dioecious, although some plants may be bisexual. Because it forms large, spiny, patches from rhizomes, Canada thistle is a particularly problematic weed in rangeland and agricultural production. Small pieces of rhizome can regenerate into plants and seed can spread to some distance in wind via the plume-like pappus. Canada thistle has been listed on the noxious weed list of 33 different U.S. states, including California.

Cheatgrass
***Bromus tectorum* L.**
Anticipated genome size: 660 Mb
Cheatgrass is native to northern Africa, Europe, and western Asia. Cheatgrass was introduced to North America independently several times via ship ballast, contaminated crop seed, and packing material. Cheatgrass now occurs on drier sites throughout most of the United States, Canada, Greenland, and northern Mexico. Cheatgrass is a tufted, annual grass; although not large, it can colonize preferred habitat in large numbers, especially after disturbance. The flowering spikelets consist of several florets that are pendent at maturity. Cheatgrass can be grazed early in the year, but as it matures the spikey awns render it unsuitable for this purpose. As such, it is inferior to perennial habitat quality for wildlife. A survey of 11 western states in 1964 showed that cheatgrass was present on at least 60 million acres. It has continued to spread in geographically and in density, so its range is significantly larger today. Cheatgrass is known to increase fire frequency in sagebrush steppe habitat and degrade the habitat for wildlife, particularly the rare sagegrouse.

Field bindweed
***Convolvulus arvensis* L.**
Anticipated genome size: 750 Mb
Field bindweed is is a perennial vine native to Africa, temperate and tropical Asia and Europe. C. arvensis most likely was introduced in North America as a contaminant in crop seed as early as 1739. It is weak-stemmed and prostrate and sprouts from multiple underground rhizomes. Aerial stems twine and can grow 1.5 meters or longer. Field bindweed has deep, spreading roots and rhizomes. Leaves are round to arrow-shaped, 2.5-5.7 centimeters long. Although the white funnel-shaped flowers are beautiful, it is considered invasive and a noxious weed in 22 States from Michigan to California. It spreads by seeds, roots and rhizomes and has a very long taproot, making it very difficult to eradicate. Despite the development of effective broad-spectrum herbicides, field bindweed is still common in row crops, gardens, roadsides, and waste areas.

Glassy-winged sharpshooter
***Homalodisca vitripennis* (Germar)**
Anticipated genome size: 1400 Mb
Unlike many significant agricultural pests in California, the glassy-winged sharpshooter is actually native to the southeastern United States. It was first detected in California in 1994. It feeds on xylem sap from many plants, including grapevines, and it vectors the bacterium *Xylella fastidiosa*, which causes Pierce's disease of grapes. The bacterium was already present in California prior to the arrival of glassy-winged sharpshooter, but it became a more serious problem with the arrival of this insect. In order to protect California agriculture from this pest, detection and control programs are in place in the state to limit its spread.

Japanese beetle
***Popillia japonica* Newman**
Anticipated genome size: unknown
Japanese beetle is native to Japan and was introduced to the United States in the early 1900s. It has spread to much of the eastern United States and is a major pest of agriculture and gardens. The adults feed on leaves, flowers, and fruits of numerous plants, including rose, grape, apple, stone fruits, and corn. The larvae live in the soil and feed on and damage roots, especially those of grasses, and they are lawn and turf pests. There is typically one generation per year. Japanese beetle is a threat to California's agriculture and environment. Trapping and aircraft inspections are part of the system protecting the state from this pest. Infestations do occur occasionally and when this happens, eradication activities occur.

Mediterranean fruit fly
***Ceratitis capitata* (Wiedemann)**
Anticipated genome size: 479 Mb
Mediterranean fruit fly is native to Africa but has spread to many other parts of the world, including Europe, Australia, and the New World tropics. In the United States, it is only known to be established in Hawaii. The adults are approximately ¼ inch in length. Typical of other fruit flies in the family Tephritidae, the adult female lays eggs inside the host fruit. The larvae that hatch from these eggs feed inside the fruit, causing economic damage. Mature larvae leave the fruit to pupate in the soil. A wide variety of fruits are attached, including citrus, avocado, peppers, stone fruits, tomatoes, pomegranates, and walnuts. Besides the direct impact of feeding,

which results in loss of production, the presence of this pest can impact trade as importing countries may restrict imports of fruit from infested areas. Mediterranean fruit fly is occasionally detected in California and these infestations have been eradicated. In southern California, there is an ongoing program where sterile male Mediterranean fruit flies are released to prevent to control any incipient infestations.

Mexican fruit fly
***Anastrepha ludens* (Loew)**
Anticipated genome size: 644.7 Mb
Mexican fruit fly occurs in Central America, Mexico, and the Rio Grande Valley of Texas. The adults are approximately one centimeter in length. Typical of other fruit flies in the family Tephritidae, the adult female lays eggs inside the host fruit. The larvae that hatch from these eggs feed inside the fruit, causing economic damage. Mature larvae leave the fruit to pupate in the soil. A wide variety of fruits are attached, including peaches, avocados, citrus, and pears. Besides the direct impact of feeding, which results in loss of production, the presence of this pest can impact trade as importing countries may restrict imports of fruit from infested areas. Mexican fruit fly is occasionally detected in California and these infestations have been eradicated.

Oriental fruit fly
***Bactrocera dorsalis* (Hendel)**
Anticipated genome size: 414 Mb
Oriental fruit fly occurs in southern Asia and neighboring islands as well as Hawaii. The adults are approximately 8 mm in length. Typical of other fruit flies in the family Tephritidae, the adult female lays eggs inside the host fruit. The larvae that hatch from these eggs feed inside the fruit, causing economic damage. Mature larvae leave the fruit to pupate in the soil. A wide variety of fruits are attached, including citrus, avocado, peppers, stone fruits, tomatoes, and walnuts. Besides the direct impact of feeding, which results in loss of production, the presence of this pest can impact trade as importing countries may restrict imports of fruit from infested areas. Oriental fruit fly is occasionally detected in California and these infestations have been eradicated.

Polyphagous shot hole borer
***Euwallacea fornicatus* (Eichhoff)**
Anticipated genome size: unknown
Polyphagous shot hole borer is an ambrosia beetle native to southeastern Asia. Adult females are approximately 1.8-2.5 mm in length; males are smaller but rarely observed. This beetle has been introduced to Israel, South Africa, and the United States (California). In California, it is present in the coastal southern part of the state and continues to spread. As an ambrosia beetle, the adult female carries fungal spores with her that inoculate wood that she tunnels into. The fungus serves as food for the adults and larvae. The most important fungus carried by this beetle, *Fusarium euwallaceae*, spreads in the affected tree and causes stress and often resulting in death of the tree (Fusarium dieback). Like most ambrosia beetles, polyphagous shot hole borer attacks a wide range of trees, probably because the fungus "garden," the food of the beetle, serves as an intermediary shielding the beetle from the particular chemical and other defenses of the tree. Trees that are attacked and are known to be capable of supporting development of the beetle

include maples (*Acer* spp.), castor bean (*Ricinus communis*), avocado (*Persea americana*), oaks (*Quercus* spp.), California sycamore (*Platanus racemosa*), and others. Polyphagous shot hole borer is a threat to the environment, agriculture, and urban trees in California.

Yellow Starthistle
***Centaurea solstitialis* L.**
Anticipated genome size: 1660 Mb
Yellow starthistle**,** *Centaurea solstitialis,* is an invasive weed that likely came to California in the late 1800s in shipments of alfalfa seed from Europe, Asia, and South America that were contaminated with seed. At this time, yellow starthistle has spread to an estimated 15 million acres in California. Yellow starthistle stems and leaves are rigid and grayish green to bluish green in color. Lower leaves have deep lobes and upper leaves are short and pointed. Sharp, one-inch long spines surround the base of bright yellow flowers. Plants can grow up to five feet tall and can produce 10,000 seeds per plant. Yellow starthistle is considered one of the most common non-native weeds in California. It can be found growing in areas along roads, in pastures, and wildlands. It grows at elevations below 7,000 feet and does well in dry, sunny areas, often becoming established where soil has recently been disturbed. The deep taproots of starthistle plants can grow up to three feet long, soaking up a great deal of soil moisture, and allowing them to flower and fruit in the dry California summers.

Artichoke thistle
Cynara cardunculus
Anticipated genome size: 1660 Mb
Cynara cardunculus (artichoke thistle) is a native of the Mediterranean that has been invading California for many years. It is a large perennial thistle (family Asteraceae) found below 500 m elevations throughout California, except in the Great Basin and Desert Regions. In California, the worst concentrations of the plant are found in Orange, Solano, and Contra Costa Counties. There are also locally dense populations in the Coast Ranges, Central Valley, and Sierra Nevada foothills This thistle is likely the wild progenitor of cultivated artichokes (*Cynara scolymus*), and the two species hybridize frequently. Artichoke thistle is also sometimes grown as an ornamental plant, and is available commercially. It reproduces by seed and sometimes by resprouting from root fragments. Artichoke thistle is a CDFA "B" rated weed. It causes serious issues in rangeland by reducing forage and limiting movement of livestock. A mature plant can produce thousands of seeds and reach heights over five feet tall. The leaves are large and choke out surrounding vegetation. It has a single large tap root that does little to hold soil in place. Artichoke thistle can be impossible to hike through and can displace native flora and fauna, thus altering the natural environment.

Italian Thistle
Carduus pycnocephalus
Anticipated genome size: 1800 Mb
Carduus pycnocephalus, with common names including Italian thistle, Italian plumeless thistle, and Plymouth thistle, is a species of thistle. It is native to: the Mediterranean region in southern Europe, North Africa, and Western Asia; East Europe and the Caucasus; and the Indian Subcontinent.The plant has been introduced in many other regions, often becoming a noxious weed or invasive species.

Carduus pycnocephalus is a classified as a noxious weed in Australia, New Zealand, Macaronesia, South Africa, the Arabian Peninsula, South America, Hawaii, and North America, especially in much of California. Because it is so widespread, it is a C-listed weed. It favors grasslands, woodlands, and chaparral vegetation types, but is especially prevalent in oak woodlands in and around the Central Valley. It is found in disturbed areas, often with basaltic soils, fertile soils, or soils with a relatively high pH (> 6.5)