Occurrence records, morphological data, and taxonomic voucher specimens for study of caraboid beetle (Coleoptera: Caraboidea) communities in early seral forests regenerating after wildfire, post-fire salvage logging, or commercial clearcuts in southwest Oregon.

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Cite this work as:

Graham S. Frank*, J.R. LaBonte, J.W. Rivers, M.G. Betts, J.Verschuyl, A.J. Kroll, M.E. Swanson, M.A. Krawchuk. 2025. Occurrence records, morphological data, and taxonomic voucher specimens for study of caraboid beetle (Coleoptera: Caraboidea) communities in early seral forests regenerating after wildfire, post-fire salvage logging, or commercial clearcuts in southwest Oregon. 9(1) p 1—7. DOI: https://dx.doi.org/10.5399/osu/cat_osac.9.1.6109.

Introduction

The composition of caraboid beetle assemblages can be sensitive to forest structure and disturbance, making them a useful indicator taxon for understanding the effects of forest management. Early seral forests regenerating from even-aged timber harvests share some structural similarities with those regenerating from natural stand-replacing disturbances. However, the degree to which timber harvests emulate natural disturbance for biodiversity is poorly understood in many temperate forest regions, including the Pacific Northwest. In this study, we compared caraboid beetle assemblages collected in pitfall traps from early seral forests regenerating from commercial clearcuts, stand-replacing wildfire, or post-fire salvage logging across a gradient in stand ages in the Klamath Mountains of southwest Oregon. To gain insight into functional differences among assemblages, we measured several morphological traits on species in our sample. Here, we present occurrence data for each species observed in the study, including voucher specimens deposited in the Oregon State Arthropod Collection, and morphological trait data generated from these specimens

Description of collection

Sampling

We sampled caraboid beetle communities using pitfall traps at a variety of early seral forest sites (stand ages 2 – 20 years) in southwest Oregon during the spring of 2019, 2021, and 2022. All forest stands had recently experienced one of three canopy-removing disturbances: clearcut timber harvest followed by herbicide applications on private lands (intensive forest management), stand-replacing wildfire (>75% basal area mortality) on public federal lands, or wildfire with post-fire salvage logging on public federal lands. Sampling was conducted as part of a study comparing bee, bird, and caraboid beetle diversity and community composition among early seral forests resulting from these three disturbance treatments (Frank 2023).

Within each stand, we installed three pitfall trap arrays (plots) with center points at least 100 m apart. Each array consisted of four traps, for a total of 12 traps per stand. We installed three traps 12 m from plot center at 0-, 120-, and 240-degree azimuths, and a fourth trap 3 m from center at a 60-, 180-, or 300-degree azimuth. Each trap consisted of two nested plastic cups (11.75 cm diameter, 473 ml volume) dug into the ground after removing any duff layer, with the lip of the top cup flush to the soil surface. Traps included two cups to facilitate sample collection, and we drilled holes in the lower cup to allow rainwater drainage. We covered traps with plywood squares elevated 2 cm above the soil surface, and used propylene glycol as a preservative liquid. We deployed traps for six weeks beginning April 24 – May 6, except for three stands that were temporarily inaccessible due to late snowfall in spring 2022 and were installed May 17–18. Samples were collected after two weeks, and again four weeks later, and were transferred to 95% ethanol immediately upon collection. Traps experienced extensive wildlife disturbance, and total sampling effort therefore varies among samples.

Identification

We separated bycatch from caraboid beetles (Coleoptera: Caraboidea: Carabidae, Cicindelidae, and Trachypachidae). Importantly, we included species in our collection that belong to clades that are considered subfamilies of Carabidae by some authors, and distinct families by others (Bousquet 2012; Duran and Gough 2020). Specifically, we included *Omus* Eschscholtz (Cicindelidae), *Clinidium* Kirby (Carabidae: Rhysodinae), and *Trachypachus* Motschulsky (Trachypachidae) in addition to genera that are consistently included in the Carabidae (Bousquet 2012).

Caraboid specimens were identified to the finest resolution possible based on morphological characteristics. Author J. R. LaBonte (JRL) made determinations for an initial subset of specimens using Lindroth (1961-1969) along with other taxonomic literature, and developed a purpose-built key for identifying the most common species in our samples. This key was used by author G. S. Frank (GSF) and undergraduate assistants to determine most of the remaining specimens, consulting JRL on species rarely captured in our study. *Omus dejeani* Reiche is readily distinguishable from the other *Omus* species in our sample on the basis of body size alone (Pearson et al. 2006), but morphological differences between *O. audouini* Reiche and *O. cazieri* van den Berghe are more subtle. Taxonomist M. G. Kippenhan determined many of the *O. audouini* and *O. cazieri* in our sample based on male aedeagi (van den Berghe 1994) and trained GSF on this distinction, but determined external morphological characteristics to be insufficient to distinguish these species in our study area (personal communication). Therefore, *O. audouini* and *O. cazieri* were identified to morphospecies when males of both species or only females were captured in a stand. *Harpalus somnulentus* Dejean and *H. opacipennis* Haldemann were also treated as a single morphospecies. Taxonomic names were confirmed with the GBIF Backbone Taxonomy using the rgbif package version 3.7.9 (Chamberlain et al. 2024) using program R version 4.2.3 (R Core Team 2023).

We collected a total of 5860 caraboid specimens, representing at least 41 species from 22 genera. Occurrence records for all specimens are archived as an attached text file to this publication, including sampling date and approximate locality information. However, the reader is directed to the corresponding author for detailed locality data, sampling effort, and ecological information about each location, including stand age and disturbance treatment category. We selected one voucher specimen for each sex of each species or morphospecies, and deposited these into the Oregon State Arthropod Collection (OSAC); accession record: OSAC_AC_2024_08_07-001.

Notable records of Stomis termitiformis (Van Dyke)

Our sample includes five records of a rarely collected species, *Stomis termitiformis* (Van Dyke, 1926), three of which have been published previously elsewhere (LaBonte 2022). The two additional records are as follows:

Oregon: Douglas Co., 19km S of Camas Valley, 42.859 °N 123.674°W, 785 m, pitfall trap, 13 V–10 VI 2022, G. S. Frank (1, OSAC, catalog number OSAC_0001300997). Douglas Co., 15 km ENE of Glendale, 42.786 °N 123.591°W, 532 m, pitfall trap, 14 V–13 VI 2021, G. S. Frank (1, OSAC, catalog number OSAC_0001300994).

The records published by LaBonte (2022) were all in clearcuts. The first of these new records was also from a regenerating clearcut. In contrast, the second of the new records was in a stand burned at high severity in the 2013 Douglas Complex fire eight years prior to sampling. Like the first three records, these records occur further east and at higher elevations than almost all previous state records of S. termitiformis, of which there are few.

Morphological measurements

For a subset of our specimens, we measured morphological characteristics expected to be important predictors of species occurrence among early seral forest stands, based on established connections between morphology and functional traits (Forsythe 1987, 1991, Ribera et al. 1999, Barton et al. 2011, Ng et al. 2018). For species captured at least six times, measurements were made on six randomly selected specimens, and we measured all specimens of species with fewer individuals in our sample. All measurements were made using a VHX-1000 digital microscope with 20-200x VH-Z20W zoom lens (KEYENCE, Itasca, IL) and were recorded to the nearest μm. Morphological data are archived as an attached text file to this publication.

Occurrence metadata

The occurrence dataset (Supplement File 1) contains the following 38 fields, which have been mapped to darwinCore biodiversity data standards (https://dwc.tdwg.org/):

datasetName: The dataset name, ESFB-carabids-OSAC-2024[version], is included in each record, in case these records are combined with other observational datasets. ESFB stands for the Early Seral Forest Biodiversity project.

basisOfRecord: All records refer to a preserved specimen, either pinned or in alcohol.

disposition: Indicates whether a specimen was accessioned into the OSAC as part of the voucher collection ('confirmedPresent') or not ('not retained'). Specimens not accessioned into OSAC are retained by the Landscape Fire and Conservation Science Research Group at Oregon State University, or in the personal collection of author JRL.

catalogNumber: If a voucher specimen for an observation was deposited into the OSAC, it is provisioned with a unique catalog number, which is presented on a printed label in both arabic human readable digits and a datamatrix barcode. As with the occurrenceID, the catalogNumber is represented in the datamatrix as a URL: http://osac.oregonstate.edu/SP/OSAC_XXXXXXXXXX, where the X's correspond to a unique 10-digit number. Observations based on specimens that were not accessioned into the museum (i.e., not retained) were not associated with a catalog number, and the field was left blank.

fieldNumber: The specimen ID number for this specific project. This identifier begins with a 3-digit stand number (001 – 093), followed by an alphabetic character for the plot within that stand (A, B, or C), the sampling round (1 or 2), and a numeric sequence in the order that a label was created for the specimen.

occurrenceID: A globally unique identification number for the observational record. It is cast differently depending on whether the voucher specimen was retained or not. For occurrence records based on specimens now housed in the collection, the occurrenceID has the prefix: 'http://osac.oregonstate.edu/SP/OSAC_' followed by the 10-digit museum-issued catalog number for the voucher specimen, e.g., http://osac.oregonstate.edu/SP/OSAC_0001300777. For occurrence records based on specimens not retained in the collection, 'SP/OSAC_' was replaced with 'OBS/ESFB_[fieldNumber]', e.g., http://osac.oregonstate.edu/OBS/ESFB_001A1_1. In both cases, these globally unique strings, which are also URLs, serve as hyperlinks to access the museum specimen or observation record.

eventType: Sample.

eventID: A project-specific identifier of a sampling event, formulated as a three-digit site number, plot (A, B, or C), and sampling round (1 or 2), e.g., 046-A-1. This is provided to link specimens collected during the same sampling event.

samplingProtocol: The method of sampling. All samples were collected using pitfall traps.

eventDate: The range of dates during which pitfall traps were open for a specific eventID.

recordedBy: Graham Frank.

location: Locality data for each specimen are provided in nine fields: *countryCode*, *stateProvince*, *county*, *locality*, *decimalLatitude*, *decimalLongitude*, *geodeticDatum*, *minimumElevation*, and *maximumElevation*. The locality field is the approximate distance and bearing from the nearest town or other geographic landmark. Sampling locations were recorded with high-precision (±1 m accuracy) GPS units. However, these are provided only to the nearest tenth-degree for publicly shared records to allow for coarse mapping in GBIF while also ensuring that detailed uses of the data directly attribute records to the dataset creators (i.e., the authors) rather than the data aggregator (i.e., GBIF). Similarly, minimumElevation and maximumElevation together provide a 100 m band in which the specimen was sampled. The dataGeneralization field provides this information for each record, and detailed geolocations are available by contacting the corresponding author.

taxon: Taxonomic classification of each specimen, checked against the GBIF Backbone Taxonomy, including eight fields: *kingdom*, *phylum*, *order*, *family*, *genus*, *specificEpithet*, *scientificName*, and *taxonRank*. The scientificName field includes the full binomial with authority and date of publication. The taxonRank field reflects whether a specimen was identified to genus or species.

sex: Male or female

verbatimIdentification: A string representing the identification in the original record. For *Harpalus* and *Omus* not identified to species, this field indicates two potential identifications that could not be distinguished consistently from artificial morphology.

identifiedBy: All specimens were identified by author and taxonomist JRL, *Omus* taxonomist M. G. Kippenhan, and by author GSF, as well as Haley Weir and Daniel Spence under supervision of GSF.

license: A creative commons license that allows users to share and adapt these data for non-commercial purposes, so long as proper attribution is made using the citation provided in bibliographicCitation. See https://creativecommons.org/licenses/by-nc/4.0/ for details.

bibliographicCitation: Included so that each record contains the appropriate attribution for the original data.

rightsholder: Oregon State University, the organization that owns the rights to the data.

ownerInstitutionCode: OSAC, the organization that owns the object or information in the record.

institutionCode: OSAC, the organization with custody of the object or information referred to in the record.

Morphology metadata

The morphology dataset (Supplement File 2) contains the following fields:

fieldNumber: The specimen ID number for this specific project, linking the morphology data to the species occurrence data.

verbatimIdentification: A string representing the identification in the original record.

sex: Male or female

code: An eight-letter code based on an abbreviation of the specimen identification, used in analysis

Measurements

The dataset contains 16 fields for morphological measurements, in micrometers. Head, pronotum, and elytra length and width are measured in dorsal view. All measurements were made in a straight line, except for aggregate measures of multiple segments where indicated.

HEAD_LENGTH: Measured from the base of head to base of labrum, following the median.
HEAD_WIDTH: Measured at the widest point, including eyes.
MANDIBLE_LENGTH: The longest straight line from hinge to tip of the left mandible.
MANDIBLE_WIDTH: Measured from the outside edge of one mandible to the other at the hinge.
ANTENNA_LENGTH: The summed length of all 11 antennomeres.
PRONOTUM_LENGTH: Following the median.
PRONOTUM_WIDTH: Measured at widest point.
PROTHORAX_DEPTH: Maximum depth of prothorax in lateral view.
ELYTRA_LENGTH: From base of scutellum to tip of elytra.
ELYTRA_WIDTH: Measured at widest point.
METASTERNUM_LENGTH: Following longitudinal suture and including antecoxal process.
TROCHANTER_LENGTH: Length of metatrochanter.
FEMUR_WIDTH: Maximum width of metafemur.
FEMUR_LENGTH: Length of metafemur.
TIBIA_LENGTH: Length of metatibia.
TARSI_LENGTH: The summed length of metatarsal segments, excluding claw.

comments: indicates reasons for missing measurements, usually broken antennae or tarsi.

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Acknowledgments

This work was funded by the Fish and Wildlife Habitat in Managed Forests Research Program through the Oregon Forest Research Laboratory and by the National Council for Stream and Air Improvement, Inc. (award WW-BIO-5024). Chinook Forest Management, Manulife Investment Management, Roseburg Forest Products, and Weyerhaeuser Company provided access to sampling sites on their private land, and managers with the USDA Forest Service and USDI Bureau of Land Management facilitated access to field sites on federal land. Sampling was conducted on lands currently owned by private timber companies or administered by the federal government, but we respectfully acknowledge that they are also primarily the ceded lands of the Cow Creek Band of the Umpqua Tribe of Indians, who have stewarded these lands for millennia. Michael G. Kippenhan helped us to identify *Omus* species. Haley Weir and Daniel Spence sorted pitfall trap specimens and made some species determinations. Many field technicians assisted with data collection: K. Burton, K. Wright, R. Rubenthaler, A. Moss, H. Payne, C. Lee, C. Kildall, J. Pow, L. Bradley, M. Sullivan, E. Tate, and S. Greenler.