CHAPTER 2. Gastropods - Multi-species Baseline Initiative

Lucid, M.K., L. Robinson, and S.E. Ehlers. 2016. Multi-species Baseline Initiative project report. 2010-2014. Idaho Department of Fish and Game, Coeur d'Alene, Idaho, USA.

Introduction

A humped coin (*Polygyrella polygyrella*) does not generate the same level of human passion as a wolverine (*Gulo gulo*), underscoring the markedly different conservation challenges faced by invertebrates and vertebrates. Incomplete species lists, complex and specialized taxonomy, and a relative lack of human interest all lead to poor information on invertebrate distribution, abundance, and basic ecology. Nevertheless, a majority of the 56 U.S. state and territory State Wildlife Action Plans (SWAPs) created in 2005 classified invertebrates as Species of Greatest Conservation Need (SGCN). Specifically, 80% (n = 45) of 2005 SWAPs included insects and 44% (n = 25) included terrestrial gastropods (http://www.usgs.gov/core_science_systems/csas/swap/sgcn/state_list.html. Accessed June 11, 2015).

Terrestrial gastropods perform a suite of ecosystem functions including fuels reduction, disease vectoring, soil building, nutrient cycling, and providing a prey base for multitudes of other species (Jordan and Black 2012). As a group, they are thought to be sensitive to a variety of human and natural influences including fire, silviculture, and habitat fragmentation (Jordan and Black 2012). Mollusks (terrestrial and aquatic) represent 37% of known animal extinctions since 1600 A.D. and currently represent 20% of species considered threatened globally (Dunk et al. 2004, Seddon 1998). Terrestrial gastropods are represented by about 1,200 North American species and an estimated 150-300 new North American species await description (Nekola 2014). The group is well described at a coarse level in North America but limited inventory data often lead to misperceptions regarding how abundant or at risk terrestrial gastropod species might be.

Collection of terrestrial gastropod data from the Idaho Panhandle and adjoining mountain ranges began in earnest in the late 1800s (Pilsbry 1940). Original collections, not without scientific merit, were at least partly driven by commercial motives. This led to data with extremely vague or inaccurate georeferencing and taxonomic designations that were monetarily motivated (Coan and Roth 1987). A handful of museum vouchered specimens are available from over the course of the 1900s (IFIWS accessed April 10, 2016) but standardized attempts to scientifically describe unoccupied areas did not occur until the end of that century (Frest 1999). Since 2000, surveys have been conducted in British Columbia (Ovaska and Sopuck 2007, Nekola et al. 2012), western Montana (Hendricks, 2003, Hendricks 2005, and Hendricks 2012), and the Idaho Panhandle (Hendricks et al. 2007) and predictive models for multiple species were developed for western Montana (Hendricks et al. 2008). Publications compiling observational records have also recently become available for the Idaho Panhandle (Bosworth 2012, Burke 2013), northeastern Washington, and northwestern Montana (Burke 2013). Two new genera have been described from the study area since 2000 (Leonard et al. 2003, Leonard et al. 2011).

Frest (1999) described a somewhat dire situation for many Idaho terrestrial gastropods and when the 2005 I-SWAP was written, many species were only known from a handful of localities (I-SWAP 2005). Despite somewhat extensive work in and adjacent to our study area, uncertainty remained as to the abundance and distribution of many terrestrial gastropod species. It was clear that an extensive standardized terrestrial gastropod survey was needed for our study area.

Gastropods are far from being the only taxonomic group lacking basic inventory data and we chose to implement a multi-taxa inventory approach by collecting opportunistic field observations for species which are easy to collect or identify in the field.

Our goals were to 1) provide distribution and occurrence data for 12 SGCN gastropods to inform the 2015 S-ranks and SWAP revisions, 2) co-locate micro-climate data loggers with terrestrial gastropod surveys, 3) co-locate terrestrial gastropod surveys with Forest Inventory and Analysis (FIA) plots which provide detailed habitat data, 4) collect opportunistic field observations for 17 species of plants, mammals, reptiles, and bees and 5) collect beetle, millipede, and shrew samples.

Methods

Study Design

We stratified our 23,000 km^2 study area into 920 5x5 km sampling cells and successfully conducted at least one terrestrial survey in 879 (96%) cells. We did not conduct surveys in 41 (4%) cells because we were unable to gain access to privately owned land (Map 2-1). Our survey sites were selected by technicians in the field (n = 172), randomly but biased to roads and trails (n = 670), and sub-selected from randomly selected FIA plots (n = 150) based on site characteristics. We biased sampling to roads and trails to increase field efficiency. Detailed site characteristic data is available for FIA plots and we conducted a sub-set of surveys on FIA plots to enable future habitat association analyses.

Basic Survey Site Selection - In 2010, field technicians selected survey locations (n = 172) in relation to bear hair snare corrals (Woods et al. 1999). Technicians traveled to an assigned grid and selected a location for a bear hair snare corral 50-150 meters from a road or trail based on landscape features such as trail and road junctions. Technicians then used a GPS unit to walk perpendicular to the road or trail 300 meters to a location where they established the invertebrate transect.

In 2011, we used ArcGIS 10.1 (Environmental Systems Research Institute, Redlands, CA) to generate a buffer around each road and trail from 50-150 m. We then generated a random point within this buffer for the survey location (n = 322). This resulted in survey sites that were randomly located, but biased to roads and trails. In 2013 we used the same technique for the remaining unsurveyed cells (n = 324) with the exception of cells where we conducted surveys at FIA plots.

FIA Survey Site Selection - We established a Memorandum of Agreement (MOU) with the US Forest Service (USFS) Rocky Mountain Research Station (RMRS) which allowed access to the locations of 150 FIA plots on public land. We were unable to finalize the MOU until 2013 after we had already sampled 477 cells. In order to distribute the FIA plots evenly across the study area, we stratified our survey points by mountain range. We chose 150 points from the 293 available from the USFS (Table 2-1).

Table 2-1. Site Characteristics of available FIA plots (n = 293)

Mountain Range	Number of sites provided by FS	Number of sites selected by MBI	Stand Age[a]			Elevation[b]			Road Distance[c]		
			Old	Mature	Young	High	Medium	Low	Far	Mid	Close
Cabinets	28	15	7	13	8	6	18	4	16	9	3
Coeur d' Alenes	84	48	6	48	30	0	55	29	15	50	19
Purcells	15	15	1	6	8	0	10	5	1	10	4
Selkirks	74	32	21	20	33	16	32	26	27	29	18
St. Joe	92	40	6	42	44	11	66	15	35	39	18
Total	**293**	**150**	**41**	**129**	**123**	**33**	**181**	**79**	**94**	**137**	**62**

[a] Stand age: Old (126-300 years), Mature (76-125 years), or Young (0-75 years)
[b] Elevation: High 1677-2303 m), Medium (1067-1676 m), or Low (457-1066 m)
[c] Road Distance: Far (> 1 mile), Mid (305 m - 1.59 km), or Close (0-304 m)

We limited the number of FIA plots to one per cell. From the 293 available FIA plots, we selected all plots which fell within Idaho Department of Fish and Game (IDFG) Wildlife Management Areas (WMA) (n = 6). To ensure a diversity of plot conditions, we then selected plots based on three characteristics: stand age, elevation, and distance to road (in order of priority). Within each mountain range, sites were first selected to achieve equal number of old, mature, and young stand sites. In the case of the Coeur d' Alenes and St. Joe mountain ranges, all of the old stand sites (except those in duplicate cells) were selected since there were few available. We sampled 2 FIA plots in St. Joe cell 1539 because one plot fell within a WMA and another was an old stand site. There were limited sites provided within the Purcell mountain range, therefore all of the sites within that range were selected regardless of site characteristics (Table 2-2).

Table 2-2. Site characteristics of selected FIA plots (n =150)

Mountain Range	Number of sites required by MBI	Stand Age[a]			Elevation[b]			Road Distance[c]		
		Old	Mature	Young	High	Medium	Low	Far	Mid	Close
Cabinets	15	5	5	5	3	8	4	9	3	3
Coeur d' Alenes	48	6	22	20	0	26	22	14	23	11
Purcells	15	1	5	8	0	10	4	1	9	4
Selkirks	32	11	10	11	9	15	8	12	12	8
St. Joe	40	5	18	18	9	20	12	18	12	11
Total	**150**	**28**	**60**	**62**	**21**	**79**	**50**	**54**	**59**	**37**

[a] Stand age: Old (126-300 years), Mature (76-125 years), or Young (0-75 years)
[b] Elevation: High 1677-2303 m), Medium (1067-1676 m), or Low (457-1066 m)
[c] Road Distance: Far (> 1 mile), Mid (305 m - 1.59 km), or Close (0-304 m)

Field Methods

At each site we deployed a survey transect (Fig. 2-1) which used a combination of techniques to collect arthropods. Gastropods were targeted with cardboard cover board traps (Hawkins 1998), leaf litter collection, and timed visual searches. We used pitfall traps to collect gastropods, ground beetles, and shrews. We recorded visual and audible opportunistic detections of plants, mammals, and reptiles. We opportunistically photographed bumblebees. We deployed a microclimate data logger at each site which recorded air temperature at basic sites (83%, n = 746) and air temperature and relative humidity at FIA sites (17%, n = 148). We used Lindgren Funnel traps (Lindgren 1983) at all FIA sites to collect flying insects.

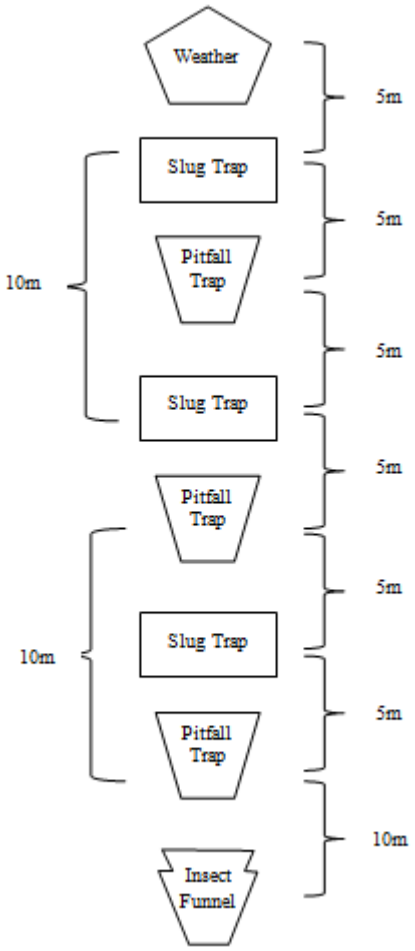


Figure 2-1. Terrestrial Transect

Microclimate data logger – A data logger was attached with nails to a conifer tree >30 cm in diameter within 40 m of the assigned point (see Chapter 5 for more detail). Beginning at the data logger, an observer used a compass to set a 45° bearing on which to set up the survey transect.

Cardboard cover boards - Three cardboard cover board traps were placed 5 meters apart from each other (Appendix II-a). In 2010 traps were initially deployed dry and un-baited (6%, $n = 63$ transects). After the first round of trapping, we began baiting traps to improve capture rates. Gardeners have long considered beer to be an effective slug attractant. Beer has been shown to be a more effective slug attractant than water (Piechowicz et al. 2014) and some commercially available molluscicides (Dankowska 2011). We tested the effectiveness of dry, water baited, and beer baited traps.

The majority of transects deployed in 2010 (11%, $n = 109$) had one dry control trap, one trap baited with 12 oz. of water, and one trap baited with 12 oz. of Natural Ice® beer. In 2011 all transects (32%, $n = 322$) had one trap each baited with 12 oz. of water, Natural Ice® beer, or Laughing Dog microbrew beer. In 2013 each of the three traps in all transects (50%, $n = 497$) were baited with 12 oz. of Natural Ice® beer. We chose Natural Ice® beer because it was the cheapest commercially available. We are grateful to Laughing Dog Brewery for graciously donating surplus beer in 2011. While there were differences in the attractiveness of differently baited traps, transect types showed little difference in effectiveness (Lucid et al. in prep.).

Traps were baited in the field by placing the trap and bait in a two gallon zip top bag and allowing the cardboard to become saturated. Traps were placed 5 m apart along the transect. Leaf litter was moved aside, the trap was placed directly on the soil, any remaining bait was poured on the trap, and the trap was covered with leaf litter to slow drying. Traps were re-visited after approximately 14 days when an observer used a magnifying glass to view the trap and remove all gastropods.

Leaf litter - Leaf litter was collected during the second visit to the survey transect. We sampled the top 10 cm of leaf litter where leaf litter associated gastropods are found (Hawkins et al. 1982) at three locations five meters perpendicular to each trap. We collected 333 mL of leaf litter from each of the three locations for a total of one liter of leaf litter from each transect. When leaf litter was not 10 cm deep we brushed adjoining litter together to collect a large enough sample. Leaf litter samples remained in the field with observers for 1-8 days and were then frozen upon return from the field. Samples were later removed from the freezer and placed in paper bags which were stapled shut to prevent contamination by other organisms while they dried at room temperature. Litter was then sifted through a series of three filters (Appendix II-a) by biological science technicians (38%, $n = 374$ samples), paid workers from a temporary job service (18%, $n = 179$ samples), college students (6%, $n = 57$ samples) and volunteer citizen naturalists (39%, $n = 382$ samples). Gastropod shells and millipedes were preserved in separate dry vials.

Timed searches - During each site visit an observer conducted at least one gastropod timed search (GTS). Beginning at the climate station, one observer spent 15 minutes searching under rocks and logs for gastropods, traveling no farther than 50 m from the climate station. FIA sites received two additional GTS in the fall of 2014.

Pitfall traps - Three 8 oz. plastic cups with a 4 cm^2 piece of Hot Shot® No-Pest fumigant strip (Spectrum Brands, Middletown, WI) were placed 5 meters apart along the transect to act as pitfall traps. A trowel was used to dig a small hole and then the rim of the cup was placed level with the ground.

During subsequent visit(s), collected rainwater was poured from the trap (amount of water was measured in 2013) through a strainer. Gastropods were handpicked from the strainer, placed in a vial, and the remaining sample (which consisted of beetles, other species, and debris) was placed into a manila coin envelope. Samples were dried in the field. Shrews (*Sorex* spp.) were occasionally captured in pitfall traps. Dead shrews were collected and preserved in 95% ethanol.

Lindgren funnel traps - We deployed un-baited Lindgren-8 funnel traps (Lindgren 1983) with dry collection cups at 148 of 150 FIA survey sites and Lindgren-8, 12, or 16 funnel traps (n = 135, 17, 31 respectively) at 22%, (n = 183) of basic survey sites. We placed a 4 cm^2 piece of fumigant strip in each collection cup. Samples were collected during each re-visit and stored in manila coin envelopes.

Opportunistic Observations - In 2013, we created a list of easily identifiable species of reptiles, mammals, invasive plants, native plants, and bumblebees which observers might encounter while working on transects. We provided training in species ID and a field identification guide. Observers recorded visual and audio detections while at the survey site and took photographs of bumblebees and one plant [rare moonwort (*Botrychium* spp.)] for later species ID verification.

Specimen Euthanasia and Storage

Gastropods - Gastropods collected on traps and by GTS were euthanized in the field by drowning. Specimens were then stored in 70% ethanol until they were identified at which point they were transferred to 95% ethanol for long term storage. Gastropods and other invertebrates collected with leaf litter were frozen and then stored in paper bags at room temperature until leaf litter was sorted. Sorted specimens were stored in dry plastic vials at room temperature. Gastropods which were sub-sampled for genetics work were either dried whole (specimens < 1 cm) or a sub-sample was dried and stored in a manila coin envelope at room temperature until laboratory work was performed.

Millipedes remained part of the leaf litter sample until the sorting process. At this time millipedes were separated from gastropod specimens and stored in dry vials at room temperature. Beetles were euthanized at the time of capture with fumigant strips. Beetles were stored in dry manila coin envelopes. Shrews expired in pitfall traps in the field. Shrew carcasses were stored in 95% ethanol until a tissue sub-sample was taken from the tail. Each tail sub-sample was dried and stored in a manila coin envelope at room temperature.

Gastropod Taxonomy

We conducted taxonomy work days ("gastropodys") where a taxonomic expert oversaw less experienced biologists and technicians in specimen identification. Bill Bosworth (Bosworth 2012) oversaw two early work events and Tom Burke (Burke 2013) oversaw a three week work period in 2014 in which we identified the majority of specimens (71%, n = 3056). Less experienced observers typically learned to identify easier specimens quickly and had an expert on hand to consult with questions. Difficult taxa groups (in particular *Cryptomastix* spp. and *Punctum* spp.) went directly to the expert for identification. We used characters defined in Bosworth (2012) and Burke (2013) to identify specimens. Characters used identify select similar species are outlined Appendix II-c.

A sub-group of slugs (7%, *n* = 312) including all *Hemphillia* spp. were sent to WGI for molecular species ID. We sub-selected all slugs we identified morphologically as *Hemphillia* spp. from the 2013 and 2014 collections for laboratory analysis at WGI. WGI developed a species test for this group of organisms using a portion of the 16S RNA gene. WGI downloaded 16S sequences from Genbank (http://www.ncbi.nlm.nih.gov/genbank/) for *Hemphillia dromedarius*, *H. camelus* and *Kootenaia burkei*. Using these sequences, they designed primers for DNA sequences which were conserved across a range of slug species, and that were located on either side of the highly variable portion of the 16S gene that WGI typically targets for species identification of mammals and birds. DNA was extracted using QIAGEN DNeasy Blood & Tissue Kits, and following QIAGEN's instructions. They then used PCR and electrophoresis conditions to produce sequence profiles of the 16S region which were compared to reference data from Genbank, as well as a profile produced by a *H. danielsi* sample which Bill Leonard provided.



We held several "gastropodys" (taxonomy work days) where a taxonomic expert oversaw less experienced biologists and technicians in specimen identification.

We morphologically identified 177 specimens as *Hemphillia* spp. in 2014 and performed the 16S species test on them. Ninety percent (*n* = 159) of samples produced sequence profiles suitable for species ID. Morphological ID matched the *Hemphillia* spp. genus for 98% (*n* = 156) of samples (*H. camelus n* = 88, *H.* unk1 *n* = 68). Three samples produced profiles consistent with *Zacoleus idahoensis* (*n* = 1), *Prophysaon* spp. (*n* = 1), and a profile which did not match available GenBank sequences (*n* = 1). Therefore, we were 98% accurate in morphologically identifying the *Hemphillia* genus. Recognizing different genera possess different levels of taxonomic difficulty, this suggests defensibility of our morphological taxonomic identification system.

Results and Discussion
Microclimate and opportunistic species results are detailed in Chapters 5 and 6 respectively.

Summary
We detected terrestrial gastropods at 86% (*n* = 851) of sites surveyed and 86% (*n* =773) of 897 cells surveyed. We collected 9,193 terrestrial gastropod specimens representing 25 families, 35 genera, and 56 species (Table 2-3). Additionally, we collected aquatic gastropods at 1% of sites (*n* = 10) representing 3 families, 2 genera, and 2 species. We detected 16 terrestrial gastropod species which were listed as SGCN in 2005 SWAPs for Idaho (*n* = 28) or Washington (*n* = 4). We detected 11 of our target SGCN terrestrial gastropods and provide evidence the 12th *(Cryptomastix mullani blandi*) should not be recognized at the sub-specific level. Non-native species tended to be located in valley bottoms with native species being found across all elevations and habitat types (Maps 2-3-5). Four of our 8 most commonly detected native terrestrial gastropods were categorized as 'rare' species and we were funded to look for them. Only 1 target 'rare' species (*Prophysaon coeruleum*) was actually rarely found in our surveys. (Figure 2-2).



Non-native species such as giant garden slugs (*Ariolimax columbianus*) were found more often in valley bottoms than higher elevations.



Robust lancetooth (*Haplotrema vancouverense*) was the 5th most commonly detected gastropod in our survey.

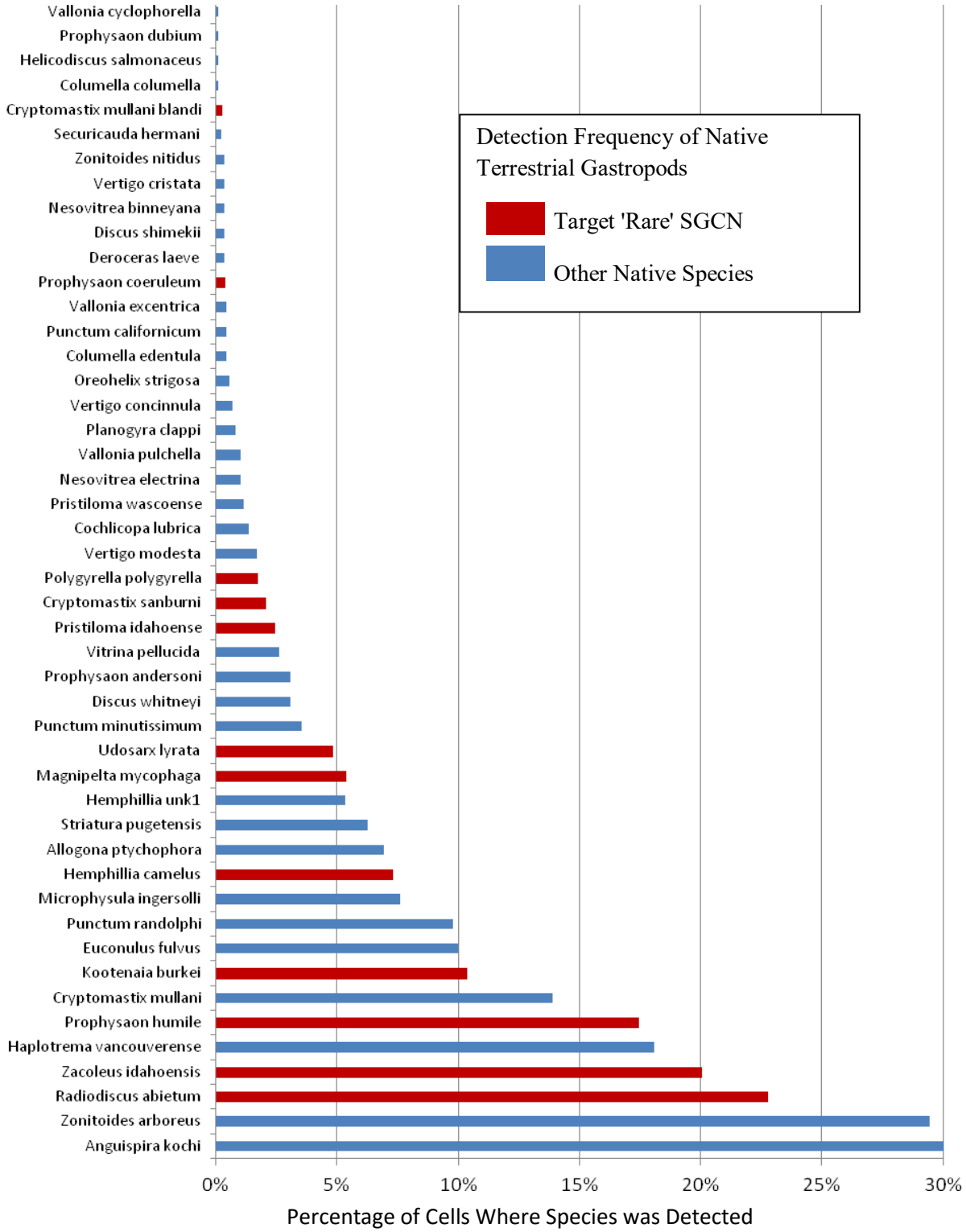


Figure 2-2. Percentage of surveyed cells (n = 879) where target 'rare' and other native terrestrial gastropods were detected.

Species Accounts

An Oregonian (Cryptomastix mullani blandi) (Table 2-3, Map 2-16)

Since the time of Henry Hemphill's 1892 description of this trinomial (Vagvolgyi 1968), 108 years passed before MBI's first gastropod survey in 2010. We are aware of only 2 reports of this sub-species in that time period. L.E. Daniels collected several specimens near Como Lake in Ravalli County Montana in 1913 (ANSP 107298 and 107330; Burke, 2013, Pilsbry 1940, Frest and Johannes 1999). Frest and Johannes (1999) examined the Ravalli specimens and determined they actually represent *C. mullani mullani* (Frest and Johannes 1999). Frest and Johannes claim to have collected *C. m. blandi* in the Coeur d' Alene River Corridor in 1990 (Frest and Johannes 1999) near the 'Post Falls' 1892 collection locality (Vagvolgyi 1968). They base their identification on several shell characteristics including dentition.

Using shell characters to differentiate polygyrid species can be exceptionally difficult (Perez 2014) as shells tend to be highly variable within species (Emberton 1995) and the use of denticles for gastropod classification can be unreliable (Tongkerd et al. 2004). Hemphill made at least part of his livelihood from selling shells commercially. He had a propensity for naming sub-specific 'varieties' and it has been suggested he may have been monetarily motivated to create more products for his sales catalogues (Coan and Roth 1987). Many of Hemphill's trinomials have not withstood taxonomic scrutiny and are currently recognized as intra-populational variants (Coan and Roth 1987). Perez et al (2014) found no support for sub-specific designation *C. m. olneyae, C. m. hemphilli*, and *C. m. latilabris* and described an urgent need for a revision of Polygyrida taxonomy.

During our surveys, we detected 2 individual snails which morphologically keyed out to *C. m. blandi* (See Table II-c-1 in Appendix II-c) on the eastern and western edges of the Selkirk Mountains. However, we believe there are little data available to continue sub-specific recognition of *C. m. blandi* for the following reasons: 1) Many of Hemphill's trinomials have not withstood systematic scrutiny (Coan and Roth 1987), 2) Hemphill may have been commercially motivated to 'create' additional varieties (Coan and Roth 1987), 3) only 2 observations, both un-substantiated, were reported from 1892-1990 (Frest and Johannes 1999), and 4) other *C. mullani* trinomials have not been supported by molecular analysis (Perez et al. 2014).

We conclude:
1) The 2 snails in our survey should simply be considered *C. mullani.*
2) The detection maps we provide of sub-specific *C. mullani* trinomials should be interpreted with skepticism until molecular evidence are shown to support the designations.
3) Taxonomic classification of this complex beyond the specific level should not be used to inform prioritized species conservation lists.

Kingston Oregonian (Cryptomastix sanburni) (Table 2-3, Map 2-21)

We collected 32 Kingston Oregonian specimens at 18 sites in 18 cells. Most detections clustered in the northern portion of the Coeur d' Alene Mountains and only 1 detection occurred outside of the Coeur d' Alenes, in the Saint Joe.

Until recently the Kingston Oregonian was considered extremely rare in Montana and possibly extinct in Idaho (http://explorer.natureserve.org/ accessed April 8, 2016). Recent museum database searches, however, have revealed specimens from 17 different collection events (IFWIS accessed April 7, 2016) the earliest of which was in 1891 (ASNP 62377, 62262). The majority of historic records are from the Coeur d' Alene Mountains with the remainder located south of the Coeur d' Alenes. The most southerly museum record is near Winchester, Idaho (ASNP 338741).

The clustering of MBI locations in the Coeur d' Alenes suggests the species could potentially be limited to that mountain range. Given the difficulty of polygyrid morphological identification (Perez et al. 2014), we recommend molecular comparison of specimens collected within and outside of the Coeur d' Alene mountains to verify Kingston Oregonian is not a Coeur a' Alene Mountain endemic.

Pale Jumping Slug (Hemphillia camelus) and Hemphillia unk1 (Table 2-3, Map 2-31-33)
The *Hemphillia* genus is endemic to the Pacific Northwest and the majority of *H.* spp have coastal distributions. Two species, Pale (*H. camelus*) and marbled (*H. danielsi*), have inland distributions (Burke 2013). *H. camelus* was our target SGCN, but we also expected to find *H. danielsi* toward the southern end of our study area (Bosworth 2012, Hendricks 2012). We did not detect *H. danielsi*. Only 2 records exist of this species in Idaho. One is an unverified museum specimen from 1960 and the other is a 2013 observation with no voucher (IFWIS accessed April 8, 2016). The 1960 voucher should be examined for taxonomic accuracy and surveys should be conducted further south on the Idaho side of the Montana border where the species range abuts with Idaho (Burke 2013) to determine if it actually occurs in Idaho. We collected 156 *H. camelus* specimens from 64 cells. We collected 91 specimens of an un-described *Hemphillia* (*H.* unk1) species from 47 cells.



Pale jumping slugs (*Hemphillia camelus*) (MBI#s OMG13L10, OMG13L11)

We identified samples to species with the partial sequence test and then produced full sequences of a 417 basepair region of 16S RNA for *H. camelus* (*n* = 33) and *H.* unk1 (*n* = 21). *H. camelus* samples yielded 3 haplotypes with 3 polymorphic sites and 0-2% divergence from most similar *H. camelus* sequence available on GenBank (accession # AY382639.1). *H.* unk1 samples yielded 8 haplotypes with 4 polymorhpic sites. *H.* unk1 samples diverged 9-10% from the *H. camelus* GenBank sequence and 12% from a GenBank *H. malonei* (a coastal species) sequence (accession# AY357656.1).

H. unk1 does appear slightly smaller than *H. camelus* but we were unable to determine a definitive external morphological character to differentiate the two species. Dr. Lyle Chichester examined the reproductive tract of specimens which had been identified genetically as *H. camelus* (*n* = **15**) and *H.* unk1 (*n* = 5). Only 5 mature *H.* unk1 specimens were available because both *H. camelus* and *H.* unk1 appear to be annual species which do not reach sexual maturity until the end of the growing season in late summer or fall. Sexually mature individuals are necessary to differentiate the species with reproductive morphology. We found 4 distinct characters to differentiate the species (Figure 2-3).

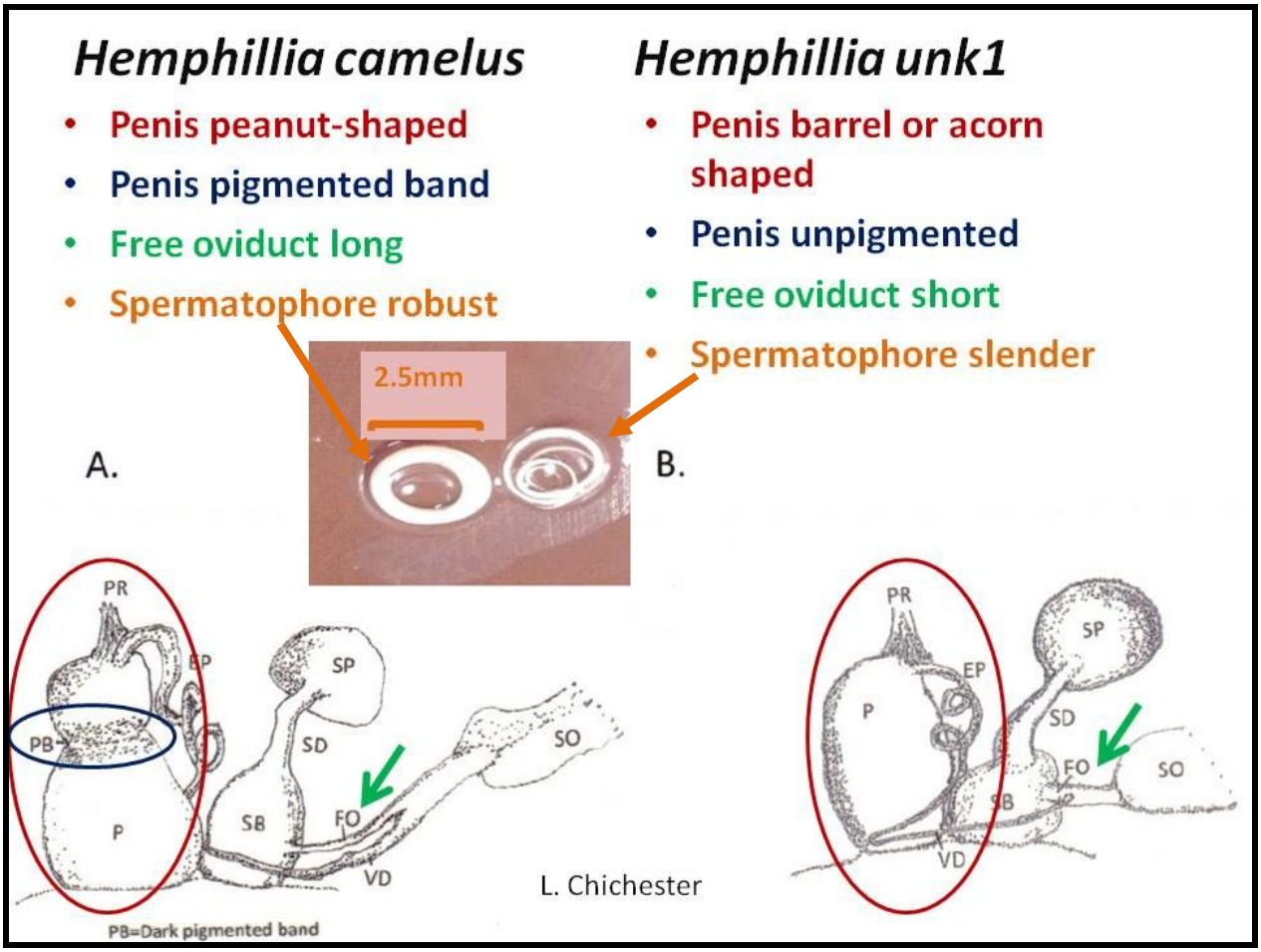


Figure 2-3. Morphological character differences of *H. camelus* and *H.* unk1 genetailia. Dissections, diagrams, and photographs by Dr. Lyle Chichester.

These two species have an interesting distribution with *H. camelus* 'ringing' the distribution of *H.* unk1. From south to north, *H. camelus* is dominant in the majority of the St. Joe and *H.* unk1 is the only of the two species detected in the Coeur d' Alenes and West Cabinets. Farther north, *H. camelus* only is in the Purcells and both species are sympatric in the Selkirks with a contact zone in the Priest Lake Basin. In the Selkirks both species were found at the same survey sites and in one case both species were captured on the same trap. Both species show associations with cooler and higher conditions than survey site averages. Future work should address ecological requirements for these species and a formal description of *H.* unk1.

Pygmy Slug (Kootenaia burkei) (Table 2-3, Map 2-34)

This little slug was only known to science for 7 years before the first 2010 MBI surveys (Leonard et al. 2003). The first specimens were described from a northern Idaho locality within the MBI study area (Leonard et al. 2003) and it was subsequently detected in Montana in 2005 (Hendricks et al. 2006) and British Columbia in 2007 (Ovasak 2007). To our knowledge, our surveys represent the first occurrence records of this species in Washington State.

This species was initially thought to be quite rare (G2) with state ranks of S1 (BC, MT) or S2 (ID) (http://explorer.natureserve.org/ accessed 8 April, 2016). However, we found pygmy slugs to be relatively abundant and well distributed across the study area. We collected 158 specimens from 91 cells. This species was found across elevation and air temperature gradients. We recommend this species not receive special conservation status within our study area.



Pygmy slug (*Kootenaia burkei*)

Magnum Mantleslug (Magnipelta mycophaga) (Table 2-3, Map 2-36)

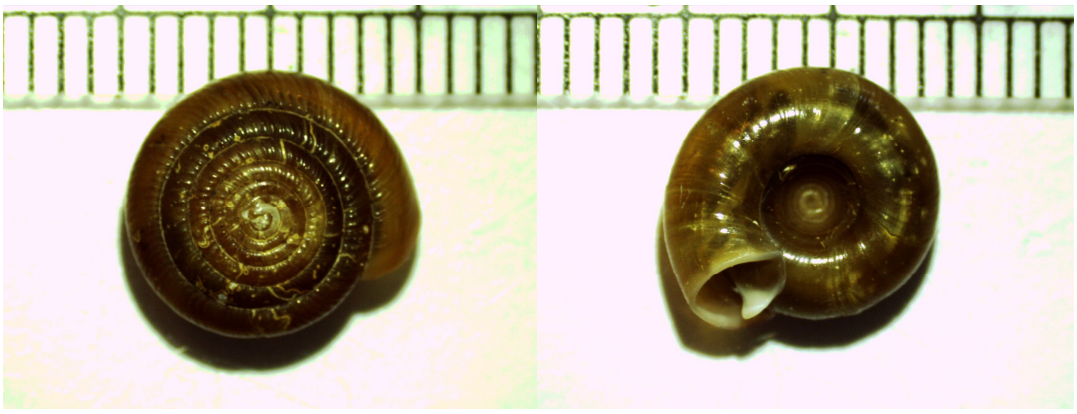
Pilsbry (1953) first described this "peculiar" genus and species from a single specimen collected in 1948 by Robert and Margaret Orr near Lolo Pass, Idaho approximately 60 km southeast of the MBI study area (Pilsbry 1953). There was not a subsequent verified detection of this species in Idaho for another 62 years until the MBI surveys began in 2010. Verified Washington observations did occur in that time frame (Burke 2013) and multiple post-2000 observations occurred in Montana (Hendricks 2012) and British Columbia (Ovasak and Sopuck 2007). Although this species was ranked as possibly extirpated (SH) (http://explorer.natureserve.org/ accessed 8 April, 2016) from Idaho when our surveys began, given the known records from adjacent states, it should not be surprising that we collected 69 specimens from 47 cells in Idaho, Washington, and Montana. This species is patchily distributed across all mountain ranges in the study area. It tends to be more strongly associated with higher elevations cooler mean annual air temperatures than other gastropod species (see Chapter 5 for more detail). We recommend additional work be done to determine ecological requirements of this species.



Magnum mantleslug (*Magnipelta mycophaga*) (MBI# OMGPS913)
Photo credit: Doug Albertson

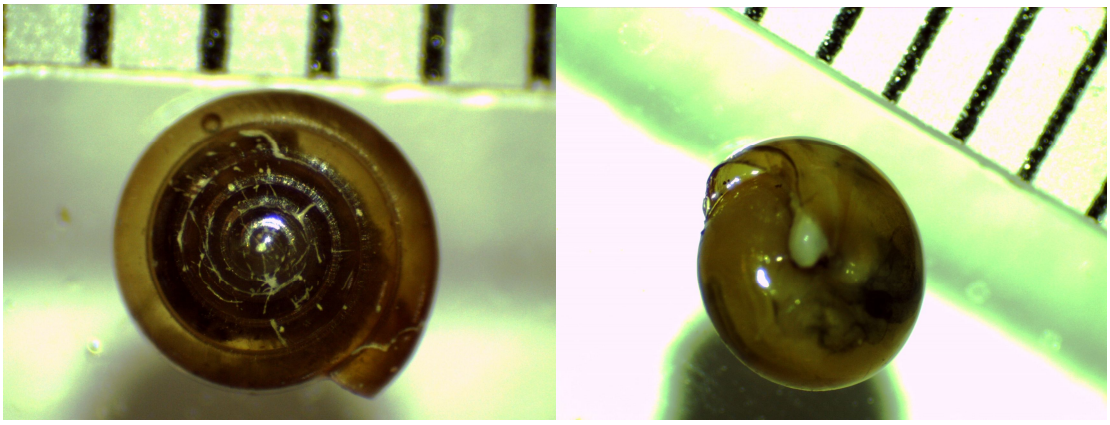
Humped Coin (Polygyrella polygyrella) (Table 2-3, Map 2-44)

Humped coins have been documented in the Blue Mountains in Oregon and Washington (Burke 2013), in northern Idaho (Bosworth 2012), and western Montana (Hendricks 2012). We collected 42 specimens from 15 cells in the Coeur d' Alene and Saint Joe Mountains. We did not detect this species in the Selkirks, West Cabinet, or Purcell Mountains. This species was associated with higher elevations and lower mean annual air temperatures than survey site averages.



Humped coin (*Polygyrella polygyrella*) (MBI# FIA1213GTSV1D) on a mm scale.

Thinlip Tightcoil (Pristiloma idahoense) (Table 2-3, Map 2-45)
This species ranges primarily from northern to central Idaho (Bosworth 2012) and has been documented in Washington and Oregon (Burke 2013). It has not been documented in Montana (Burke 2013). We collected 57 thinlip tightcoil specimens from 21 cells which were well distributed across the Saint Joe, Coeur d' Alene and Selkirk Mountains in Idaho and Washington. The Selkirk detections, including 1 detection about 1.5 km from the International Border, suggest this species likely occurs in British Columbia. We did not detect it in the Purcell Mountains. Although we did not detect the species in Montana, we did collect 1 individual from the West Cabinet Mountains about 10 km from the state line, which suggests the species could occur in the Montana portion of that mountain range. This species was associated with higher elevations and lower mean annual air temperatures than survey site averages.



Thinlip tightcoil (*Pristiloma idahoense*)
(MBI#s FIA1392GTSV1A, FIA1118GTSV1B)
on a mm scale.

Blue-grey Taildropper (Prophysaon coeruleum) (Table 2-3, Map 2-48)
Taildroppers are so named because they can dislocate a portion of their tail as a predatory defense strategy. Blue-grey taildroppers are primarily a coastal species which extend from northern California to Vancouver Island (Burke 2013). A disjunct population with genetic (Wilke and Duncan 2004) and morphologic (Ovaska et al. 2004) differences from the coastal population occurs in the Idaho portion of our study area (Bosworth 2012). We collected 4 individuals from 3 cells from the Coeur d' Alene River Corridor and Mountains, the same general area where the species has been previously reported (Ovaska et al. 2004). We do not have reason to suspect this species would be more difficult to detect than other, smaller, slugs such as pygmy slugs which were commonly detected. Therefore, we conclude this species is relatively rare and conservation efforts should be applied to known populations.

Smoky Taildropper (Prophysaon humile) (Table 2-3, Map 2-50)

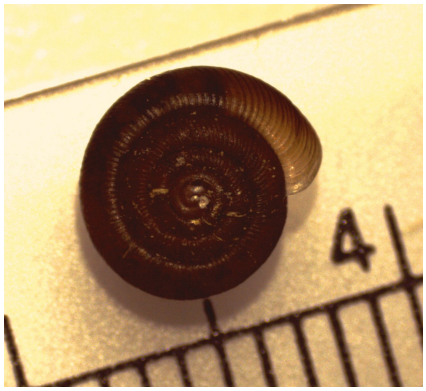
Smoky taildroppers are known to occur in Idaho and Montana (Burke 2013) and our collection of 376 specimens from 153 cells provides confirmation of an Idaho-Montana distribution which does not include Washington or British Columbia. We did not detect this species in the Purcell or Selkirk Mountains indicating a biogeographic barrier which prevents expansion from the West Cabinet Mountains and subsequently into adjoining British Columbia or Washington. Rocky mountain tailed frogs (Nielson et al. 2001) and Coeur d' Alene salamanders (Wilson et al. 1997) show similar distributional patterns. Smoky taildroppers are associated with slightly higher elevations and slightly lower mean annual air temperatures than survey site averages. This common species appears to be an Idaho-Montana endemic. The shared distributional pattern may provide unique opportunities to investigate co-evolution and multi-taxa phlyogeographic patterns which could provide important information for landscape conservation within the study area.



Smoky taildropper (*Prophysaon humile*) (MBI# OMGPS1013)
Photo credit: Doug Albertson

Fir Pinwheel (Radiodiscus abietum) (Table 2-3, Map 2-54)

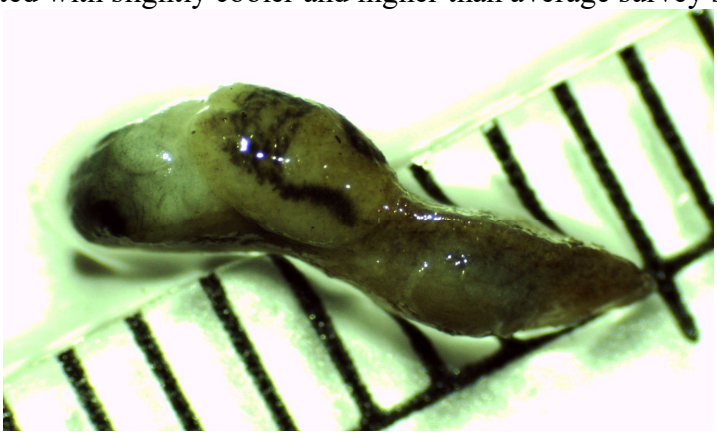
Fir pinwheels occur in Idaho, Montana, Oregon, Washington (Burke 2013) and British Columbia (Nekola 2012). This species was considered an S2 imperiled species in 2010 at the beginning of the MBI surveys (http://explorer.natureserve.org/ accessed 8 April, 2016). Since that time, both our work and others (Hendricks 2012) have demonstrated this species is much more common than previously thought. In fact, we detected this 'imperiled' species more commonly than all but 2 other terrestrial gastropod species (Figure 2-2). We collected 505 specimens from 200 survey cells at sites which tended to be slightly cooler and higher elevation than survey site averages. This species should not be considered a candidate for species of conservation concern lists and emphasizes the need for accurate and current inventory data to make such decisions.



Fir pinwheel (*Radiodiscus abietum*) (MBI# FIA1371T1V3B) on a mm scale.

Lyre Mantleslug (Udosarx lyrata) (Table 2-3, Map 2-57)

Named for the hourglass-shaped shading on their mantle, lyre mantleslugs are another species which emphasize the importance of accurate and current inventory data. Classified as critically imperiled (S1) (http://explorer.natureserve.org/ accessed 8 April, 2016) when this project began, our data and others (Hendricks 2012) have demonstrated this species to be much more common than previously thought. We collected 109 specimens from 42 cells primarily in the Saint Joe Mountains. Lyre mantleslugs were identified from 3 widely spaced cells north of the Joe. We confirmed species ID morphologically and plan to conduct genetic analyses to determine if the more northern samples are appropriately taxonomically assigned. Documented occurrences remain only in Montana (Hendricks 2012) and Idaho but the proximity of our detections to Washington suggest lyre mantleslugs may be detected in that state in the future. This species was associated with slightly cooler and higher than average survey sites.



Lyre mantleslug (*Udosarx lyrata*) (MBI# FIA1064GTSVA) on a mm scale.

Sheathed Slug (Zacoleus idahoensis) (Table 2-3, Map 2-67)

Prior to MBI, sheathed slugs were documented to occur in Montana (Hendricks 2012, Burke 2013) and Idaho (Bosworth 2012, Burke 2013). We found this species to be well distributed across all mountain ranges and states in our study area. We collected 385 specimens from 176 cells and it was the 4th most common terrestrial gastropod in our survey (Figure 2-2). To our knowledge, we provide the first state records for Washington. Our detections adjacent to the international border suggest likely occurrence in British Columbia. The heaviest concentrations of this species were in the West Cabinet and Purcell Mountains. Detections decreased in the southern portions of the study area with fewer detections in the Coeur d' Alenes and Saint Joe. The species was common in the Selkirks but was nearly absent from the Priest Lake Basin. A similar pattern of non-detection in this basin was observed for *Allogona ptychophora* (Map 2-6) and *Anguispira kochi* (Map 2-7). Future work should investigate if this is a natural biogeographic or, rather, an anthropogenic influenced pattern. This species showed no association with a temperature or elevational gradient and should not be considered for special status.



Sheathed slug (*Zacoleus idahoensis*) (MBI# OMGPS613)
Photo credit: Doug Albertson

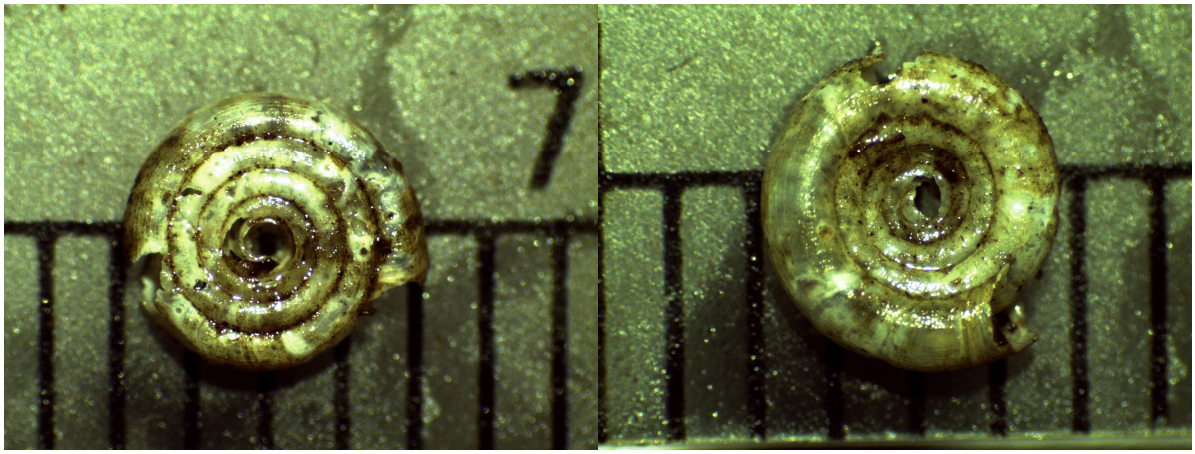
2005 Idaho SGCN Maintaining SGCN Status in 2015

Western Flatwhorl (Planogyra clappi) (Table 2-3. Map 2-43)

This species was listed as an I-SGCN in 2005 and 2015. We detected 11 specimens from 7 sites. All detections were from the Selkirks with 1 Idaho specimen and 10 Washington specimens. Our Washington detections are not surprising but are the first verified occurrences in the eastern half of that state (Burke 2013).

Salmon Coil (Helicodiscus salmonaceus) (Table 2-3, Map 2-30)

This distinctive species was listed as an I-SGCN in 2005 and 2015. The single specimen we collected in 2013 was the first record in our study area since 1931 (IFWIS accessed September 8, 2016). Our surveys suggest the current global imperiled status (GS2) is warranted and this species should be a priority for conservation resources.



Salmon coil (*Helicodiscus salmonaceus*) (MBI# C727GTSV2B) on a mm scale.

Species Without 2005 SGCN Status Upgraded to SGCN Status in 2015

Shiny Tightcoil (Pristiloma wascoense) (Table 2-3, Map 2-46)

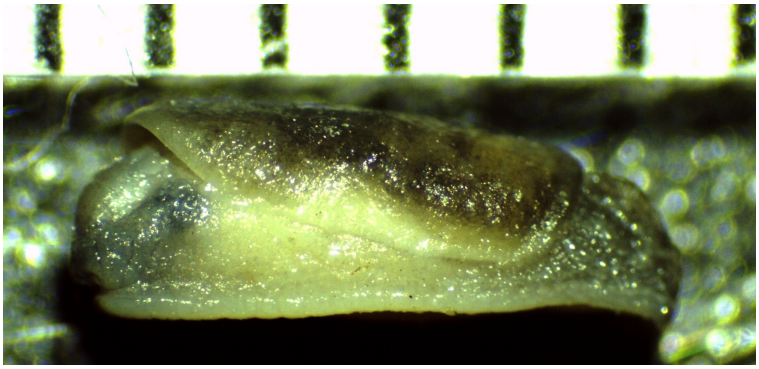
This species was not an I-SGCN in 2005. We collected 13 specimens from 10 cells in widely distributed sites across the study area including Washington, Idaho, and Montana and all mountain ranges except the Purcells. It was listed as I-SGCN in 2015 because it is a cool air associate (See chapter 5 for more details).

Prophysaon dubium (Table 2-3, Map 2-49)

This species was not an I-SGCN in 2005. We collected 2 specimens from 1 Idaho site near the Saint Joe River. It was listed as an I-SGCN in 2015 because it is a regional endemic which appears to be uncommon and is known only from limited sites.

Rocky Mountain Axetail (Securicauda hermani) (Table 2-3, Map 2-55)

S. hermani was not yet known to science when the 2005 SGCN list was created (Leonard et al. 2011) and was therefore not included in the 2005 I-SWAP. We collected 1 specimen near where the original specimens were described (Leonard et al. 2011) and 1 specimen from the Purcell Mountains in Montana. Both specimens key out morphologically to *S. hermani*. It should be kept in mind that another axetail species, Cascades Axetail (*Carinacauda stormi*), has nearly identical external morphological features to *S. hermani* but differs distinctly in internal anatomy (Leonard et al. 2011, Burke 2013). The *S. hermani* designation of the Montana specimen should be viewed with caution until further taxonomic work can be completed.



Rocky mountain axetail (*Securicauda hermani*) (MBI# C1204GTSV1) on a mm scale.

Other Notable Detections

Columbia Oregonian (Cryptomastix hendersoni) (Table 2-3, Map 2-15)

Although this species supposedly only occurs in the Columbia and Snake River areas of Washington, Oregon, and Idaho (Burke 2013), the 4 shells we collected from 2 localities fit the description of only *C. hendersoni.* Although the shells characteristics of *Crptomastix* spp. can be quite variable with continual intergrades between them (Burke 2013, Perez et al. 2014), of the many *Cryptomastix* identified during this project, these shells alone had the distinct appearance of *C. hendersoni*. We recommend caution in definitive range expansion of this species until a thorough molecular analysis of the genus in Idaho is complete.

Mountainsnails (Oreohelix spp.) (Table 2-3, Map 2-15)

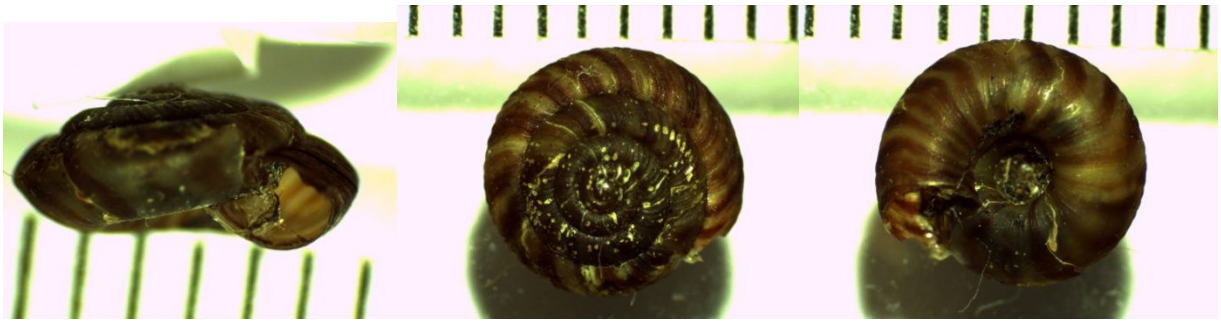
This genus displays remarkable diversity and hosts many species and subspecies which occur in extremely limted geographic areas (Burke 2013). This diverse speciation is more typical of dryer areas and not likely a major evolutionary factor within our mesic study area. Regardless, taxonomy of this group remains difficult and we did not feel we could definitively identify the majority of our *Oreohelix* spp. specimens beyond genus by morphological characters alone. Based on distribution and expected abundance, most *Oreohelix* in our collection are likely *O. strigosa*. It is possible we misidentified some *Oreohelix* spp. specimens as *Anguispira kochi* as these two genera are similar (Burke 2013).

Ribbed Spot (Punctum californicum) (Table 2-3, Map 2-51)

We collected 4 specimens from 4 well distributed Idaho cells. This is the first verified Idaho occurrence of this species. Its range is primarily the southwestern United States, but it has been collected in Glacier National Park (Burke 2013). Our detections fill in a hole in this disjunct distribution but we recommend molecular analysis to investigate taxonomic accuracy of the southwestern and northwestern collections.

Vertigos (Vertigo spp.) (Table 2-3, Maps 2-60-65)
We were surprised we did not detect this genus more frequently as they are widespread and thought to be common in North America (Burke 2013). We do not believe this is due to the small size of the genus as we detected smaller species such as *Punctum* spp. regularly. However, vertigos may have a tendency to be annual species which would mean very small juveniles may not have been detected earlier in the survey season.

'New' Non-native Records
Rotund Disc (Discus rotundatus) (Table 2-3, Map 2-25)
This European species (Kerney and Cameron 1979) is introduced to North America. We collected 3 specimens of this distinctive snail in 3 cells in Washington and Idaho. We believe these are the first detections of this species in both states (Burke 2013).



Rotund disc (*Discus rotundatus*) (MBI# FIA62GTSV3B) on a mm scale.

Pacific Bananaslug (Ariolimax columbianus) (Table 2-3, Map 2-8)
Frest (1999) described this well known coastal species as "fairly common" in the northern third of Idaho. We collected 20 specimens from 3 cells, but it remains unclear if the species is truly native (Bosworth 2012). Genetics work may elucidate the source of Idaho populations (i.e., native or introduced).



Pacific bananaslugs *(Ariolimax columbianus)* (MBI# C844GTSV2)

Conclusions
Our surveys represent the first comprehensive inventory of terrestrial gastropods in the Idaho Panhandle and adjoining mountain ranges. This baseline inventory sets the stage for long term monitoring which we recommend be implemented to assess changes in species abundance and distribution over time.

Literature Cited

Bosworth, W. 2012. Terrestrial Gastropods of Idaho. Idaho Department of Fish and Game. Boise, ID. 109 pp.

Burke, T.E. 2013. Land Snails and Slugs of the Pacific Northwest. Photographs by W.P. Leonard. Oregon State University Press, Corvallis, OR. 334 pp.

Coan, E. V., & B. Roth. 1987. The malacological taxa of Henry Hemphill. The Veliger, 29(3), 322-339.

Dankowska, E. 2011. Effectiveness of beer traps and molluscicides as means of gastropod control. Folia Malacologica 19(4):273.

Dunk J.R., Zielinski, W.J., and H.K. Preisler. 2004. Predicting the occurrence of rare mollusks in Northern California forests. Ecological Applications 14(3):713–729.

Emberton, K. C. 1995. Sympatric convergence and environmental correlation between two land-snail species. Evolution 49:4 69–475.

Jordan, S. F. and S. H. Black. 2012. Effects of Forest Land Management on Terrestrial Mollusks: A Literature Review. The Xerces Society for Invertebrate Conservation Portland, Oregon, 1-87.

Frest, T. J. 1999. A Review of the land and freshwater Mollusks of Idaho. Final report to the Idaho Conservation Data Center, Idaho Department of Fish and Game, 600 South Walnut, P.O. Box 25, Boise, Idaho 83707. 281 pp. plus appendices.

Henderson, J. 1936. Mollusca of Colorado, Utah, Montana, Idaho, and Wyoming supplement. The University of Colorado Studies 23:81-145.

Hendricks, P. 2003. Status and conservation management of terrestrial mollusks of special concern in Montana. Montana Natural Heritage Program. Helena, MT.

Hendricks, P. 2005. Surveys for Animal Species of Concern in Northwestern Montana. Montana Natural Heritage Program. Helena, MT.

Hendricks, P., B. Maxwell, S. Leonard, and C. Currier. 2008. Surveys and Predicted Distribution Models for Land Mollusks on USFS Northern Region Lands: 2007. Montana Natural Heritage Program. Helena, MT.

Hendricks, P., B. A. Maxell, S. Lenard and C. Currier. 2007. Land Mollusk Surveys on USFS Northern Region Lands: 2006. Report to the USDA Forest Service, Northern Region. Montana Natural Heritage Program, Helena, Montana. 11 pp. plus appendices.

Hendricks, Paul. 2012. A Guide to the Land Snails and Slugs of Montana. A report to the U.S. Forest Service - Region 1. Montana Natural Heritage Program, Helena, MT. vii + 187 pp. plus appendices.

Kerney, M.P. and R.A.D. Cameron. 1979. A field guide to the land snails of Britain and northwestern Europe. Collins, London.

Leonard, W. P., L. Chichester, C. H. Richart, and T. A. Young. 2011. *Securicauda hermani* and *Carinacauda stormi*, two new genera and species of slug from the Pacific Northwest of the United States (Gastropoda: Stylommatophara: Arionidae), with notes on *Glibates oregonius* Webb 1959. Zootaxa. 2746:43-56.

Leonard, W.P., L. Chichester, J. Baugh, and T. Wilke. 2003. *Kootenaia burkei*, a new genus and species of slug from northern Idaho, United States (Gastropoda: Pulmonata: Arionidae). Zootaxa, 355: 1-16.

Lucid, M.K., S.A. Cushman, S.E. Ehlers, and L. Robinson. In Prep. Survey methods for terrestrial gastropods.

Miller, Walter Bernard, Richard L. Reeder, Noorullah Babrakzai and H. Lee Fairbanks. 1984. List of new and revised Recent taxa in the North American terrestrial Mollusca (north of Mexico) published since 19 March 1948. Part 1. Tryonia 11:i+14 pp.

Nekola, J., Coles, B., & Horsak, M. 2012. Land Snail Biodiversity Assessment for the Selkirk Mountains Park Region in Southeastern British Columbia.

Nekola, J.C. 2014. Overview of the North American terrestrial gastropod fauna. American Malacological Bulletin. 32(2):225-235.

Nielson, M., K. Lohman, and J. Sullivan. 2001. Phylogeography of the tailed frog (*Ascaphus truei*): implications for the biogeography of the Pacific Northwest. Evolution, 55(1), 147-160.

Ovaska, K., W. P. Leonard, L. Chichester, T. E. Burke, L. Sopuck, and J. Baugh. 2004. Prophysaon coeruleum Cockerell, 1890, blue-gray taildropper (Gastropoda: Arionidae): new distributional records and reproductive anatomy. Western North American Naturalist, 64(4), 538-543.

Ovaska, K. and L. Sopuck. 2007. Surveys for terrestrial gastropods at risk in southeastern British Columbia, July–September 2007. Prepared for Ministry of Environment, Victoria, BC.

Perez, K. E., Defreitas, N., Slapcinsky, J., Minton, R. L., Anderson, F. E., & Pearce, T. A. 2014. Molecular phylogeny, evolution of shell shape, and DNA barcoding in Polygyridae (Gastropoda: Pulmonata), an endemic North American clade of land snails. American Malacological Bulletin, 32(1), 1-31.

Piechowicz, B., P. Grodzicki, I. Piechowicz, & K. Stawarczyk. 2014. Beer as olfactory attractant in the fight against harmful slugs Arion Lusitanicus Mabille 1868. Chemistry-Didactics-Ecology-Metrology, 19(1-2):119-125.

Pilsbry, H. A. Land Mollusca of North America (North of Mexico). 1940. Academy of Natural Sciences of Philadelphia, monograph no. 3, I (2):i-ix, 575-1113.

Pilsbry, H. A. 1953. *Magnipelta*, a new genus of Arionidae from Idaho. The Nautilus 67:37-38.

Seddon, M. B. 1998. Red listing for mollusks: a tool for conservation? Journal of Conchology Special Publication 2:27–44.

Tongkerd, P., T. Lee, S. Panha, J. B. Burch, and D. Ó Foighil. 2004. Molecular phylogeny of certain Thai gastrocoptine micro land snails (Stylommatophora: Pupillidae) inferred from mitochondrial and nuclear ribosomal DNA sequences. Journal of Molluscan Studies 70: 139–147.

Vagvolgyi, Joseph. 1968. Systematics and evolution of the genus *Triodopsis* (Mollusca: Pulmonata: Polygyridae). Harvard Univ. Museum of Comparative Zoology Bulletin 136(7):145-254.

Wilke, T., & N. Duncan. 2004. Phylogeographical patterns in the American Pacific Northwest: lessons from the arionid slug Prophysaon coeruleum. Molecular Ecology, 13(8), 2303-2315.

Wilson, A. G., E. M. Wilson, C. R. Groves and R. L. Wallace. 1997. US Distribution of the Coeur d'Alene salamander (*Plethodon idahoensis,* Slater and Slipp). The Great Basin Naturalist, 57(4), 359-362.

Woods, J. G., D. Paetkau, D. Lewis, B. N. McLellan, M. Proctor, and C. Strobeck. 1999. Genetic tagging of free-ranging black and brown bears. Wildlife Society Bulletin 27:616–627

Table 2-3. Terrestrial gastropods detected during primary surveys and 2005 and 2015 S rank and SGCN status

Common Name	Latin Name	% cells detected (*n*)	cells detected *n* (%)	2005 ID S Rank	2015 ID S Rank	2005 ID SGCN	2015 ID SGCN
MBI Target Species							
Thinlip Tightcoil	*Pristiloma idahoense*	2.39% (21)	21 (2)	S1	S4	Y	N
Lyre Mantleslug	*Udosarx lyrata*	4.78% (42)	42 (5)	S1	S3	Y	N
Pale Jumping-slug	*Hemphillia camelus*	7.28% (64)	64 (7)	S2	S2	Y	Y
Pygmy Slug	*Kootenai burkei*	10.35% (91)	91 (10)	S2	S5	Y	N
Humped Coin	*Polygyrella polygyrella*	1.71% (15)	15 (2)	S2	S4	Y	N
Smoky Taildropper	*Prophysaon humile*	17.29% (152)	152 (17)	S2	S4	Y	N
Fir Pinwheel	*Radiodiscus abietum*	22.64% (199)	199 (23)	S2	S5	Y	N
Sheathed Slug	*Zacoleus idahoensis*	19.91% (175)	175 (20)	S2	S5	Y	N
Blue-gray Taildropper	*Prophysaon coeruleum*	0.34% (3)	3 (0)	SNR	S1Q	N	Y
Kingston Oregonian	*Cryptomastix sanburni*	2.05% (18)	18 (2)	SH	S3	Y	Y
Magnum Mantleslug	*Magnipelta mycophaga*	4.89% (43)	43 (5)	SH	S2	Y	Y
Cryptomastix mullani blandi	*Cryptomastix mullani blandi*	0.23% (2)	2 (0)	SNR	S2	Y	N*

Common Name	Latin Name	% cells detected (n)		2005 ID S Rank	2015 ID S Rank	2005 ID SGCN	2015 ID SGCN
MBI Detected Species							
Western Flat-whorl	*Planogyra clappi*	0.80% (7)	7 (1)	S1	S1	Y	Y
Salmon Coil	*Helicodiscus salmonaceus*	0.11% (1)	1 (0)	S2	S2	Y	Y
Columbia Oregonian	*Cryptomastix hendersoni*	0.23% (2)	2 (0)	SNR	S3	N	N
Shiny Tightcoil	*Pristiloma wascoense*	1.14% (10)	10 (1)	SH	S2	Y	Y
Idaho Forestsnail	*Allogona ptychophora*	6.83% (60)	60 (7)	SNR	S4	N	N
Banded Tigersnail	*Anguispira kochi*	29.92% (263)	263 (30)	SNR	S5	N	N
Pacific Bananaslug	*Ariolimax columbianus*	0.34% (3)	3 (0)	Exotic			
Brown-banded Arion	*Arion circumscriptus*	0.11% (1)	1 (0)	Exotic			

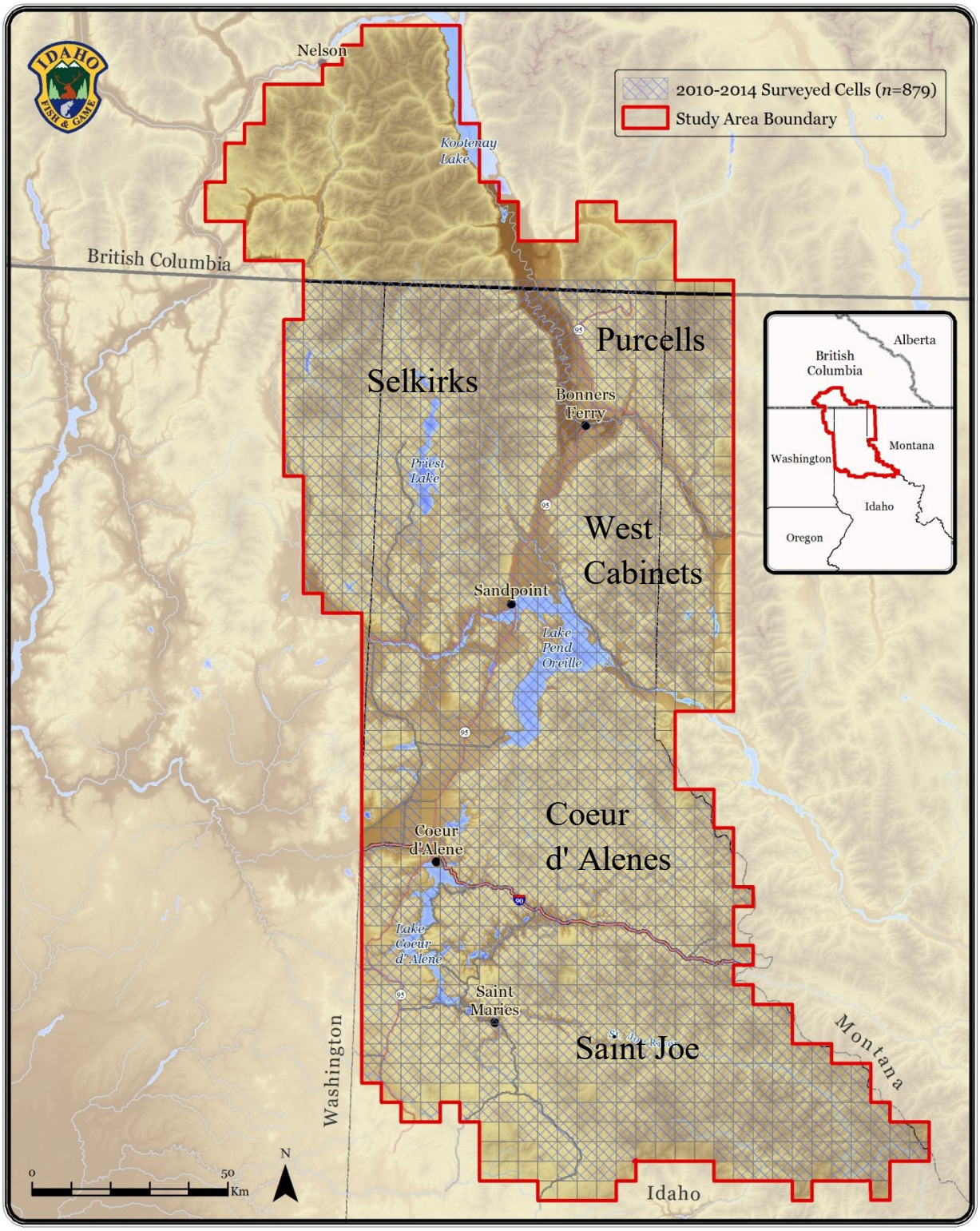
Chocolate Arion	*Arion rufus*	0.80% (7)	7 (1)	Exotic			
Dusky Arion	*Arion subfuscus*	0.57% (5)	5 (1)	Exotic			
Columella columella	*Columella columella*	0.11% (1)	1 (0)	SNA	S3	N	N
Toothless Column snail	*Columella edentula*	0.46% (4)	4 (0)	SNA	S3	N	N
Glossy Pillar	*Conchlicopa lubrica*	1.37% (12)	12 (1)	SNR	S3	N	N
Cryptomastix mullani hemphilli	*Cryptomastix mullani hemphilli*	5.80% (51)	51 (6)	?	S4	N	N*
Coeur d' Alene Oregonian	*Cryptomastix mullani mullani*	4.66% (41)	41 (5)	?	S4	N	N*
Cryptomastix mullani olneyae	*Cryptomastix mullani olneyae*	4.10% (36)	36 (4)	?	S4	N	N*
Meadow Fieldslug	*Deroceras laeve*	0.34% (3)	3 (0)	SNA	S3	N	N
Longneck Fieldslug	*Deroceras panormitanum*	0.23% (2)	2 (0)	Exotic			
Gray Fieldslug	*Deroceras reticulatum*	2.05% (18)	18 (2)	Exotic			
Rotund Disc	*Discus rotundatus*	0.34% (3)	3 (0)	Exotic			
Striate Disc	*Discus shimekii*	0.34% (3)	3 (0)	SNR	S3	N	N
Forest Disc	*Discus whitneyi*	3.07% (27)	27 (3)	S4	S4	N	N
Brown Hive	*Euconulus fulvus*	10.01% (88)	88 (10)	S4	S4	N	N
Robust Lancetooth	*Haplotrema vancouverense*	17.97% (158)	158 (18)	SNR	S5	N	N
Hemphillia unk1	*Hemphillia unk1*	5.12% (45)	45 (5)	ND	S2Q	NA	Y
Giant Gardenslug	*Limax maximus*	1.71% (15)	15 (2)	Exotic			
Spruce Snail	*Microphysula ingersolli*	7.62% (67)	67 (8)	SNR	S4	N	N
Blue Glass	*Nesovitrea binneyana*	0.34% (3)	3 (0)	SNR	SNA	N	N
Amber Glass	*Nesovitrea electrina*	1.02% (9)	9 (1)	SNR	S3	N	N
Oreohelix spp.	*Oreohelix spp.*	2.28% (20)	20 (2)	NA			
Oreohelix strigosa	*Oreohelix strigosa*	0.57% (5)	5 (1)	SNR	SNR	N	N
Garlic Glass-snail	*Oxychilus alliarius*	0.11% (1)	1 (0)	Exotic			
Reticulate Taildropper	*Prophysaon andersoni*	3.07% (27)	27 (3)	SNA	S4	N	N
Papillose Taildropper	*Prophysaon dubium*	0.11% (1)	1 (0)	SNR	S2Q	N	Y
Punctum californicum	*Punctum californicum*	0.46% (4)	4 (0)	SNR	SNR	N	N
Small Spot	*Punctum minutissimum*	3.53% (31)	31 (4)	SNR	S4	N	N
Conical Spot	*Punctum randolphii*	9.78% (86)	86 (10)	SNR	S5	N	N
Rocky Mountain Axetail	*Securicauda hermani*	0.23% (2)	2 (0)	ND	S1	NA	Y
Northwest Striate	*Striatura pugetensis*	6.26% (55)	55 (6)	SNA	S4	N	N

Silky Vallonia	*Vallonia cyclophorella*	0.11% (1)	1 (0)	SNR	S4	N	N
Iroquois Vallonia	*Vallonia excentrica*	0.46% (4)	4 (0)		S4	N	N
Lovely Vallonia	*Vallonia pulchella*	1.02% (9)	9 (1)	SNR	S3	N	N
Vertigo concinnula	*Vertigo concinnula*	0.68% (6)	6 (1)	SNR	SNR	N	N
Crested Vertigo	*Vertigo cristata*	0.34% (3)	3 (0)		SNR	N	N
Cross Vertigo	*Vertigo modesta*	1.25% (11)	11 (1)	SNR	S4	N	N
Vertigo modesta parietalis	*Vertigo modesta parietalis*	0.57% (5)	5 (1)				
Vertigo modesta sculptilis	*Vertigo modesta sculptilis*	0.34% (3)	3 (0)				
Western Glass-snail	*Vitrina pellucida*	2.62% (23)	23 (3)	SNR	S4	N	N
Quick Gloss	*Zonitoides arboreus*	29.35% (258)	258 (30)	SNR	S5	N	N
Black Gloss	*Zonitoides nitidus*	0.34% (3)	3 (0)	SNR	S5	N	N

[a] S-rank averages calculated only from numberical S-ranks. SH (possibly exitrpated), SNR (species not ranked) are not included in calclulation.

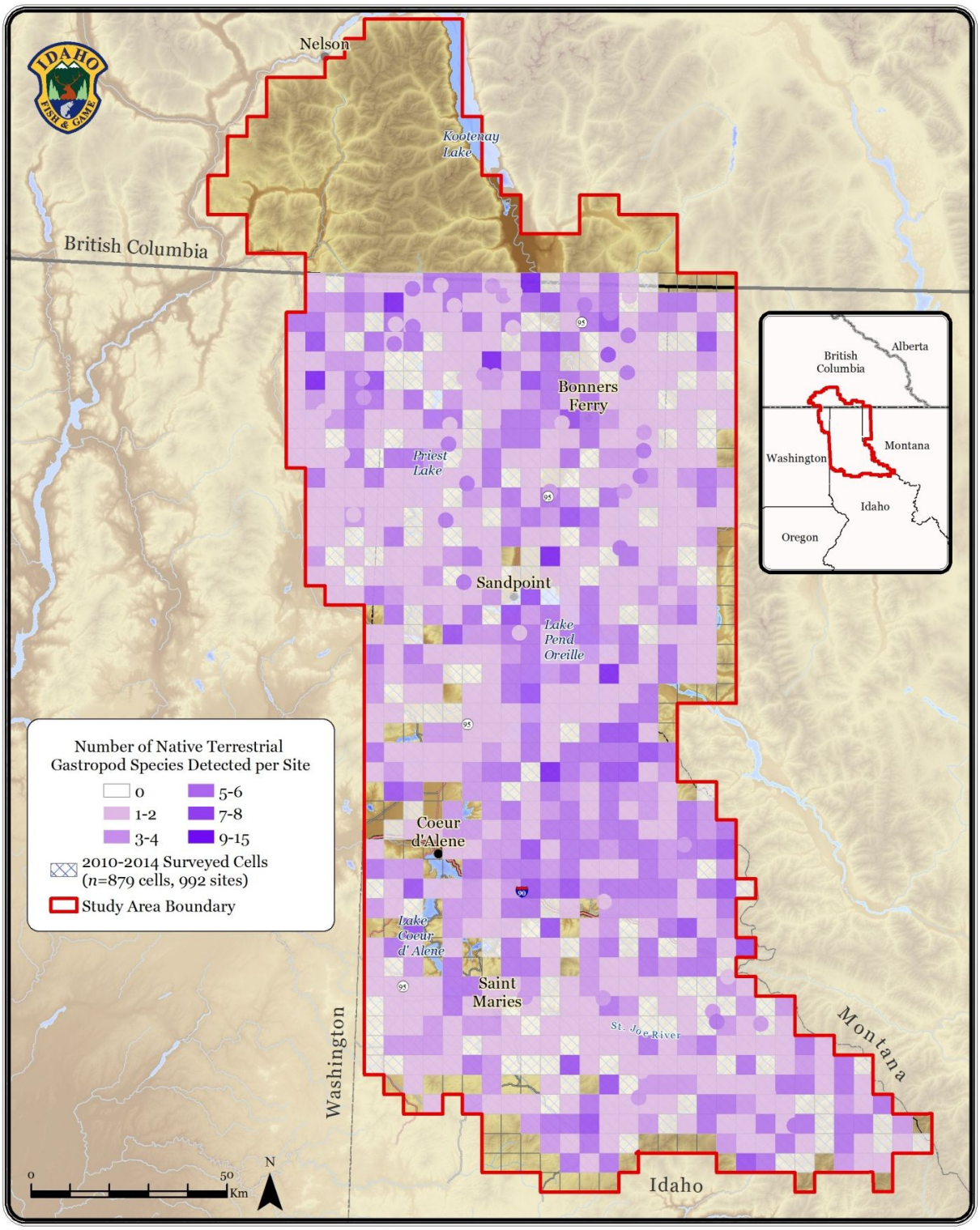
*Trinomial ranked as SGCN at specific epithet level.

ND: Not Described



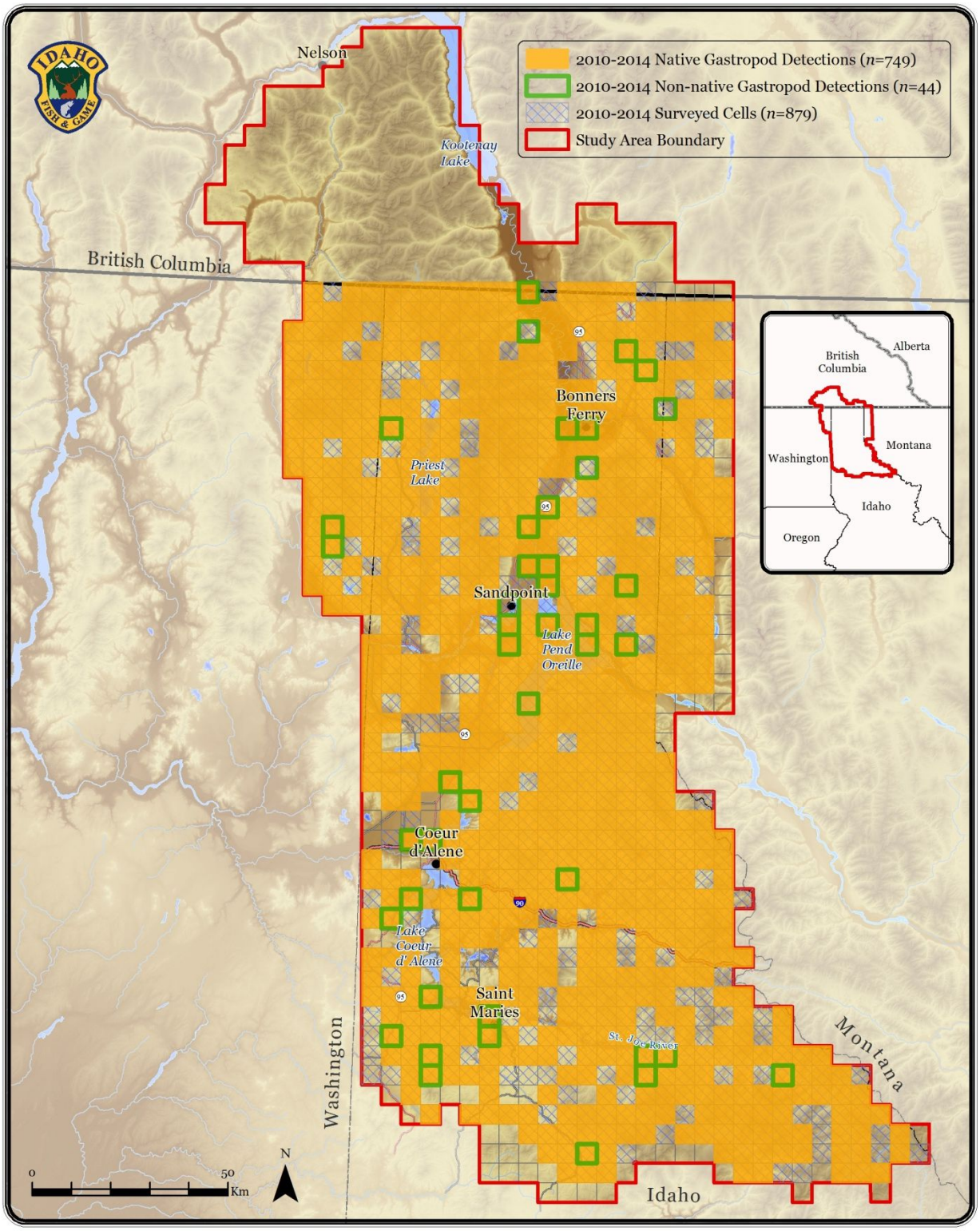
Map 2-1. 879 5x5 km cells surveyed for gastropods from 2010-2014.

Multi-species Baseline Initiative: Native Terrestrial Gastropod Species Richness



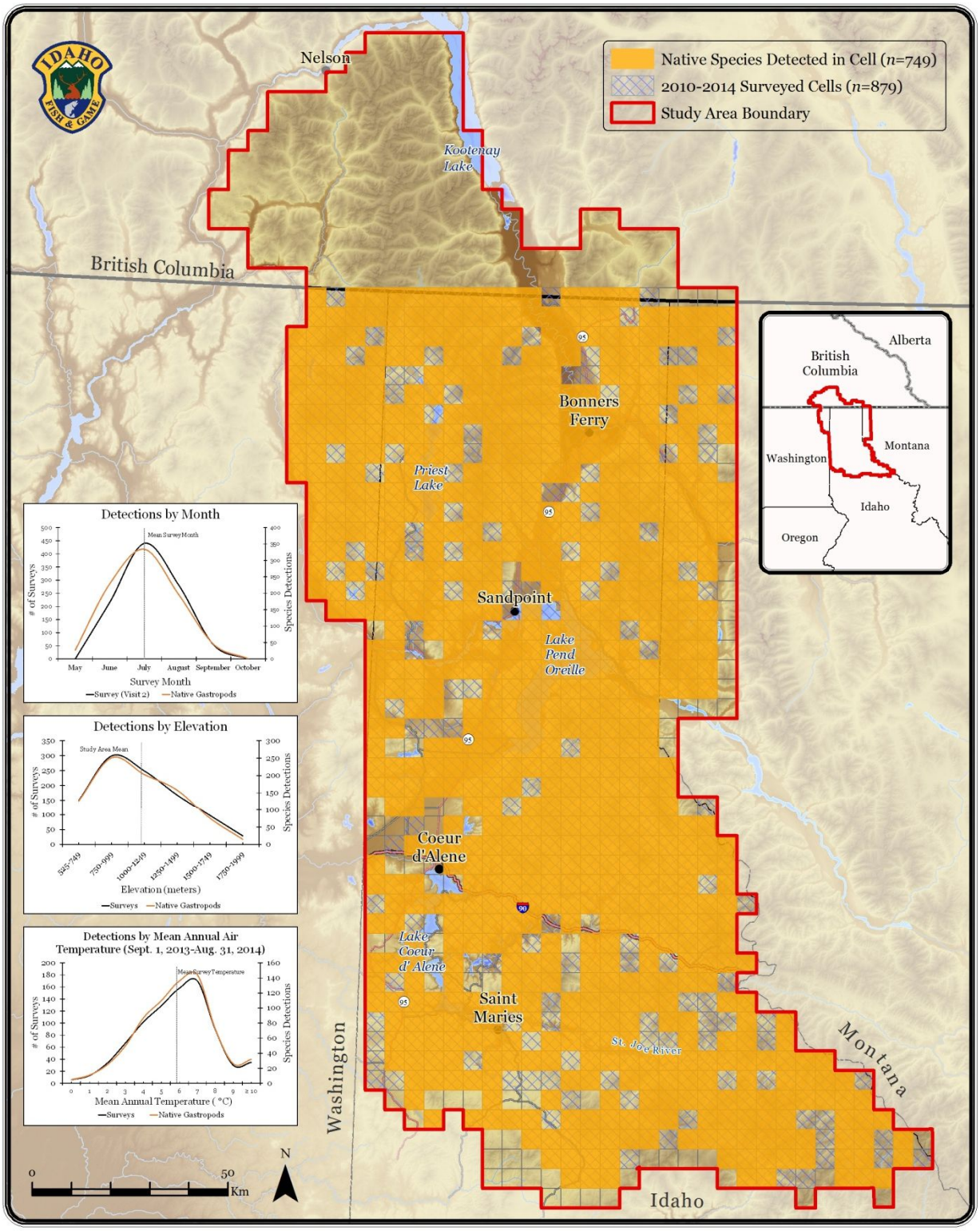
Map 2-2.

Multi-species Baseline Initiative: Native and Non-native Gastropod Detections



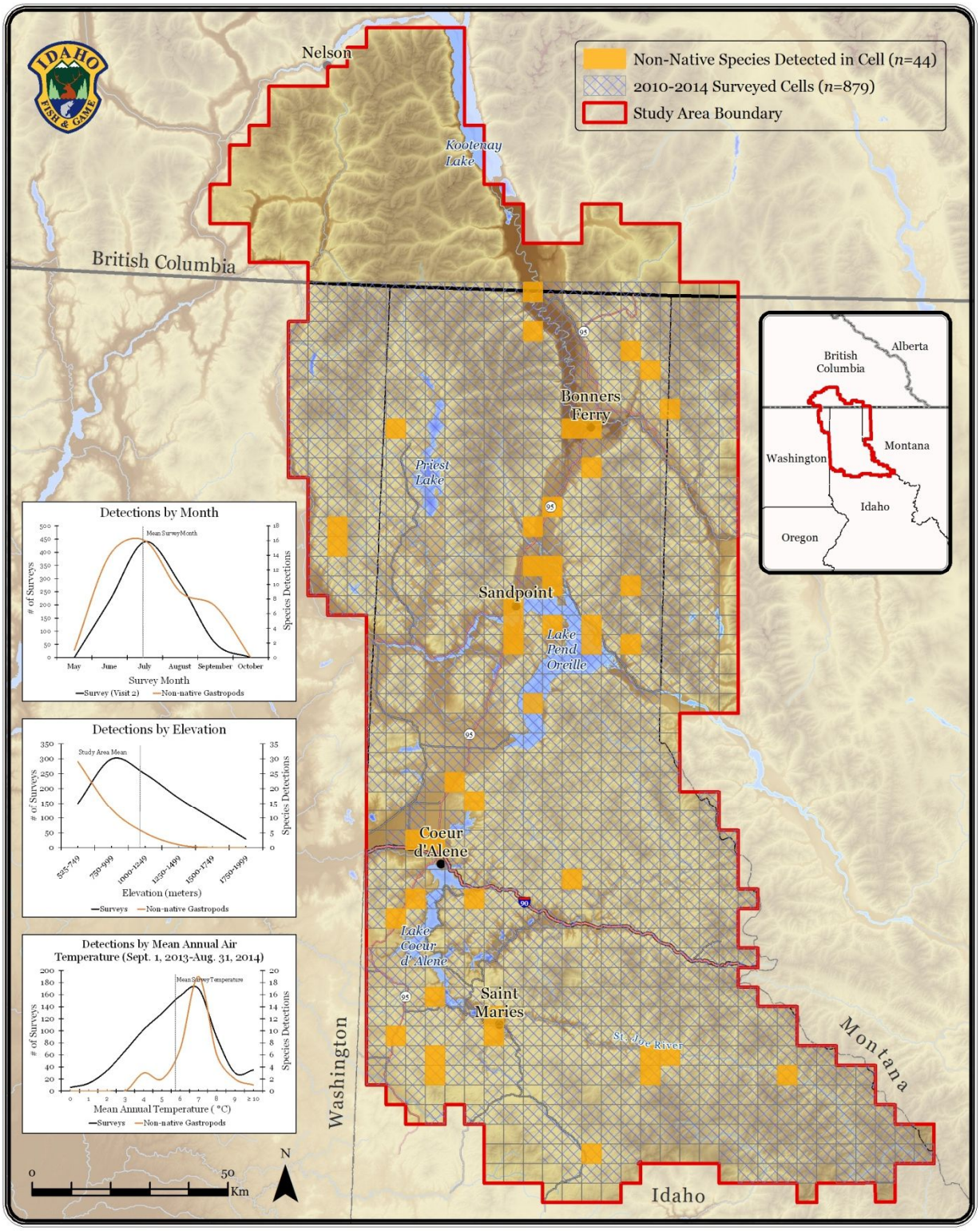
Map 2-3.

Multi-species Baseline Initiative: Native Gastropod Detections



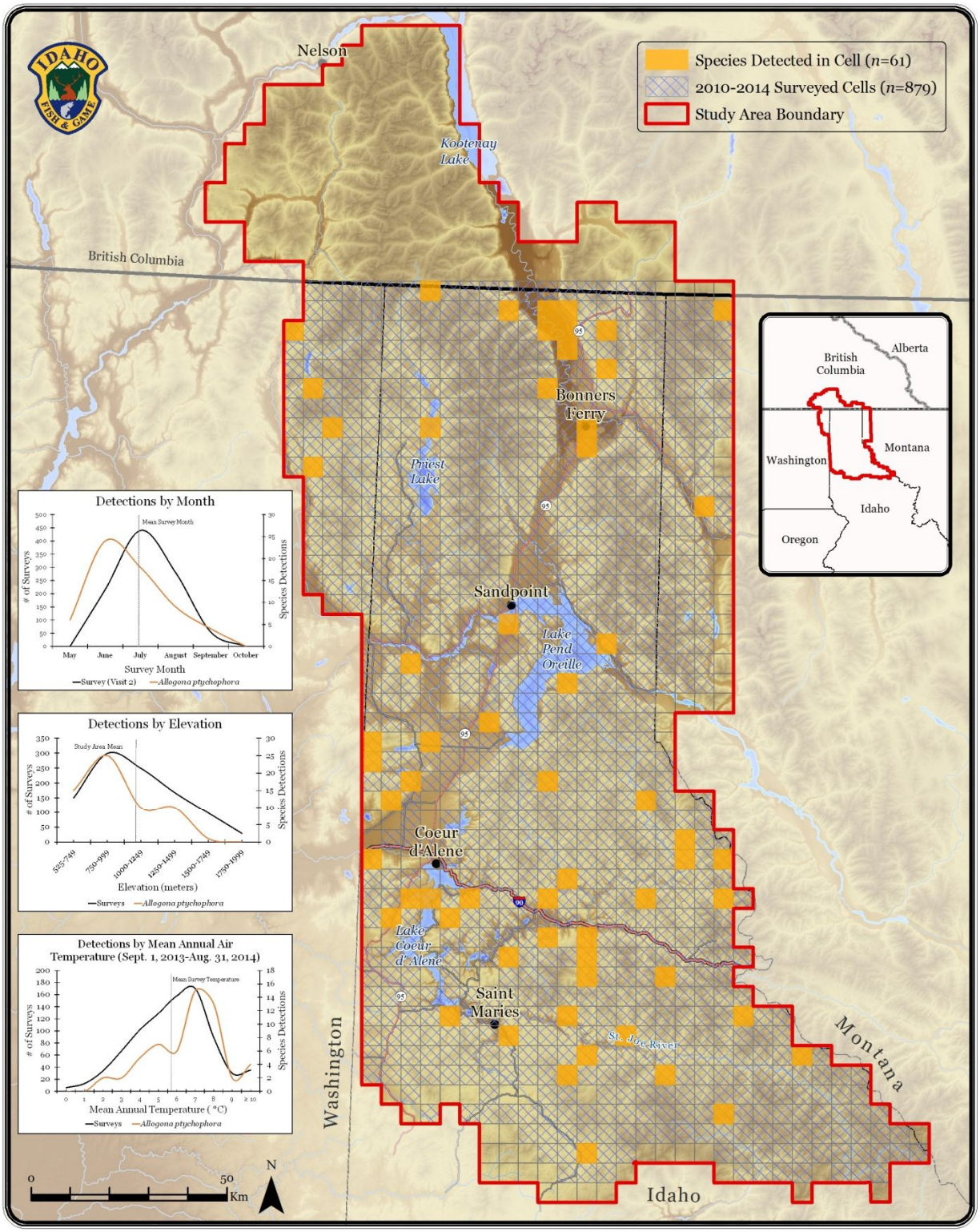
Map 2-4.

Multi-species Baseline Initiative: Non-native Gastropod Detections



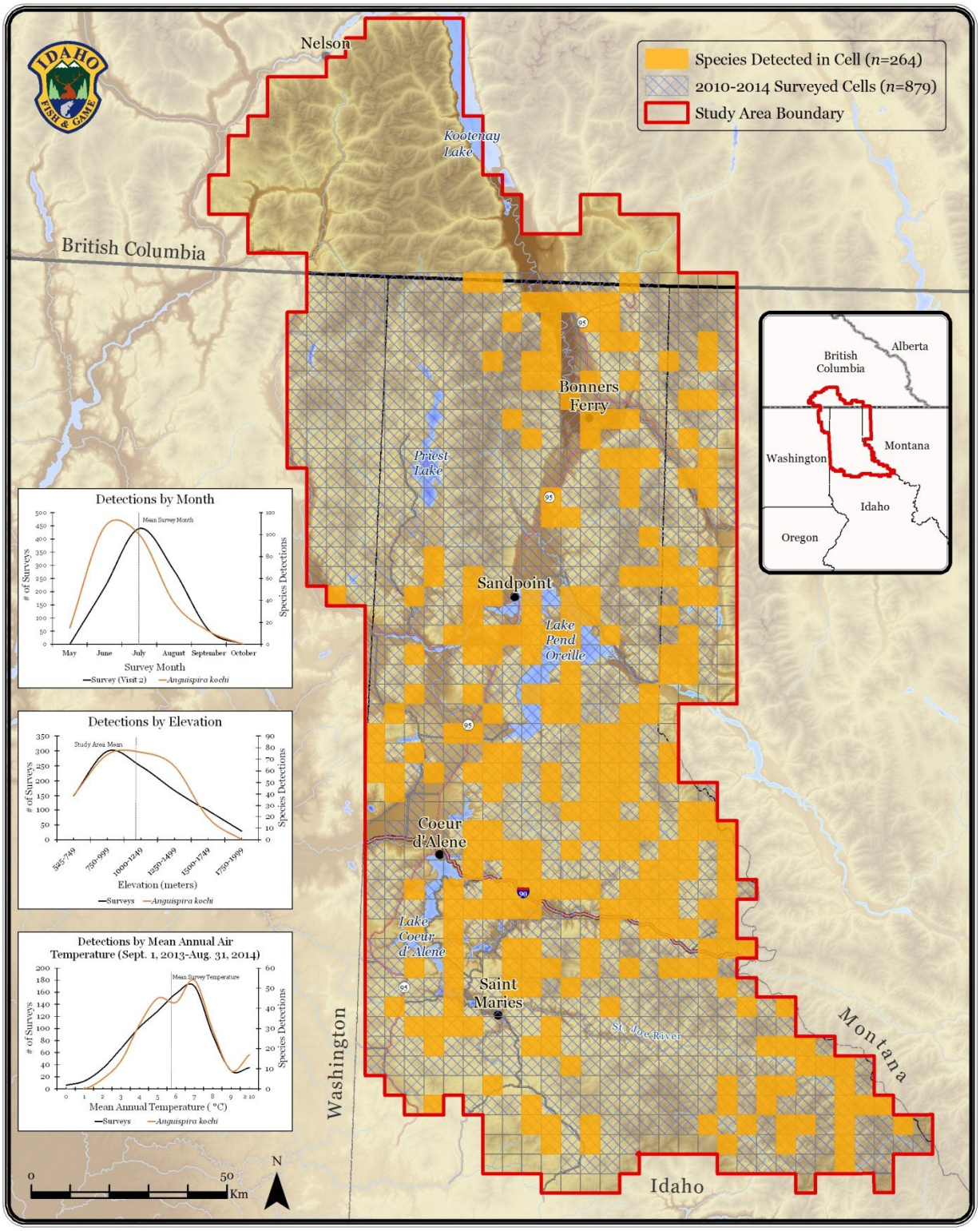
Map 2-5.

Multi-species Baseline Initiative: Idaho Forestsnail (*Allogona ptychophora*) Detections



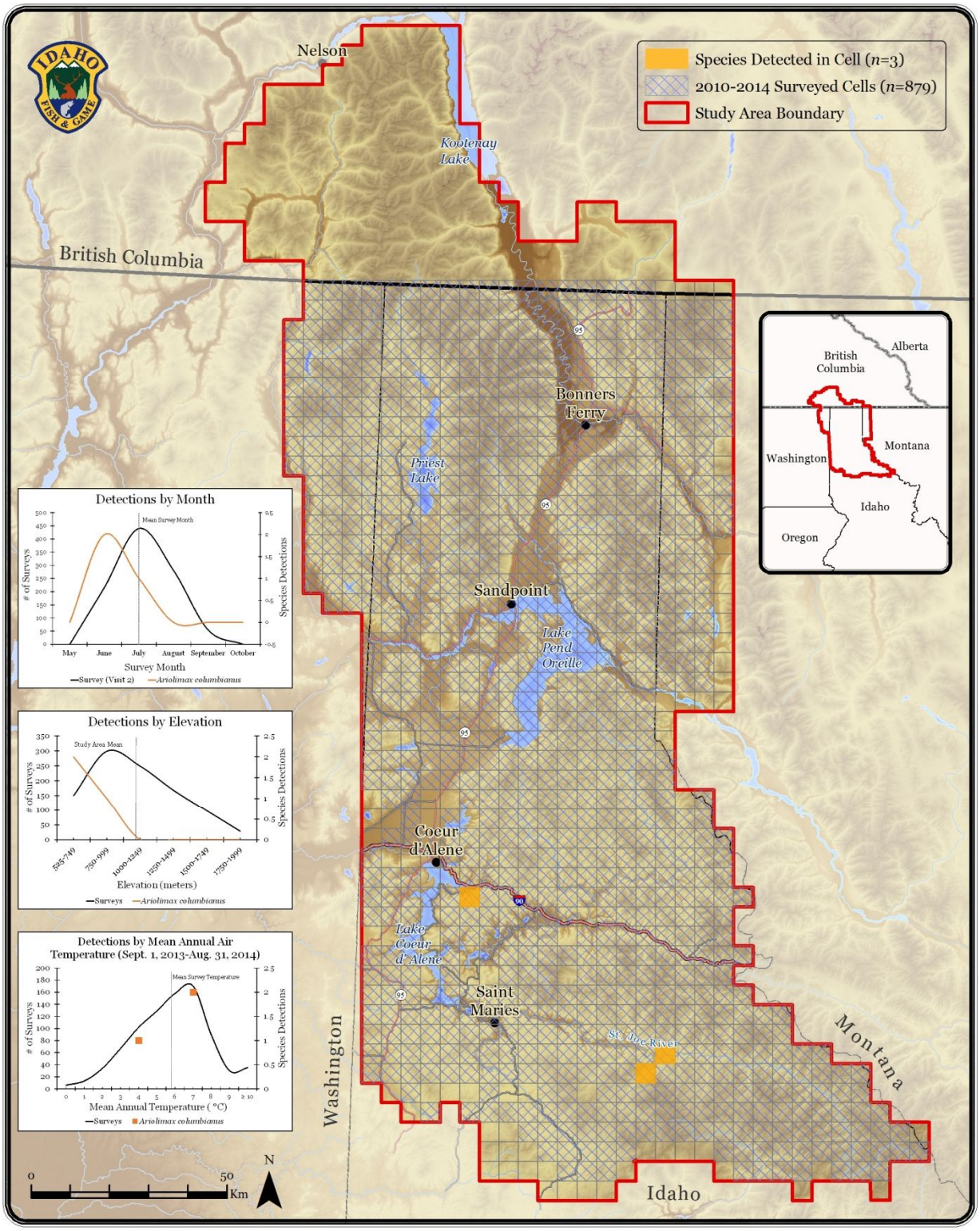
Map 2-6.

Multi-species Baseline Initiative: Banded Tigersnail (*Anguispira kochi*) Detections



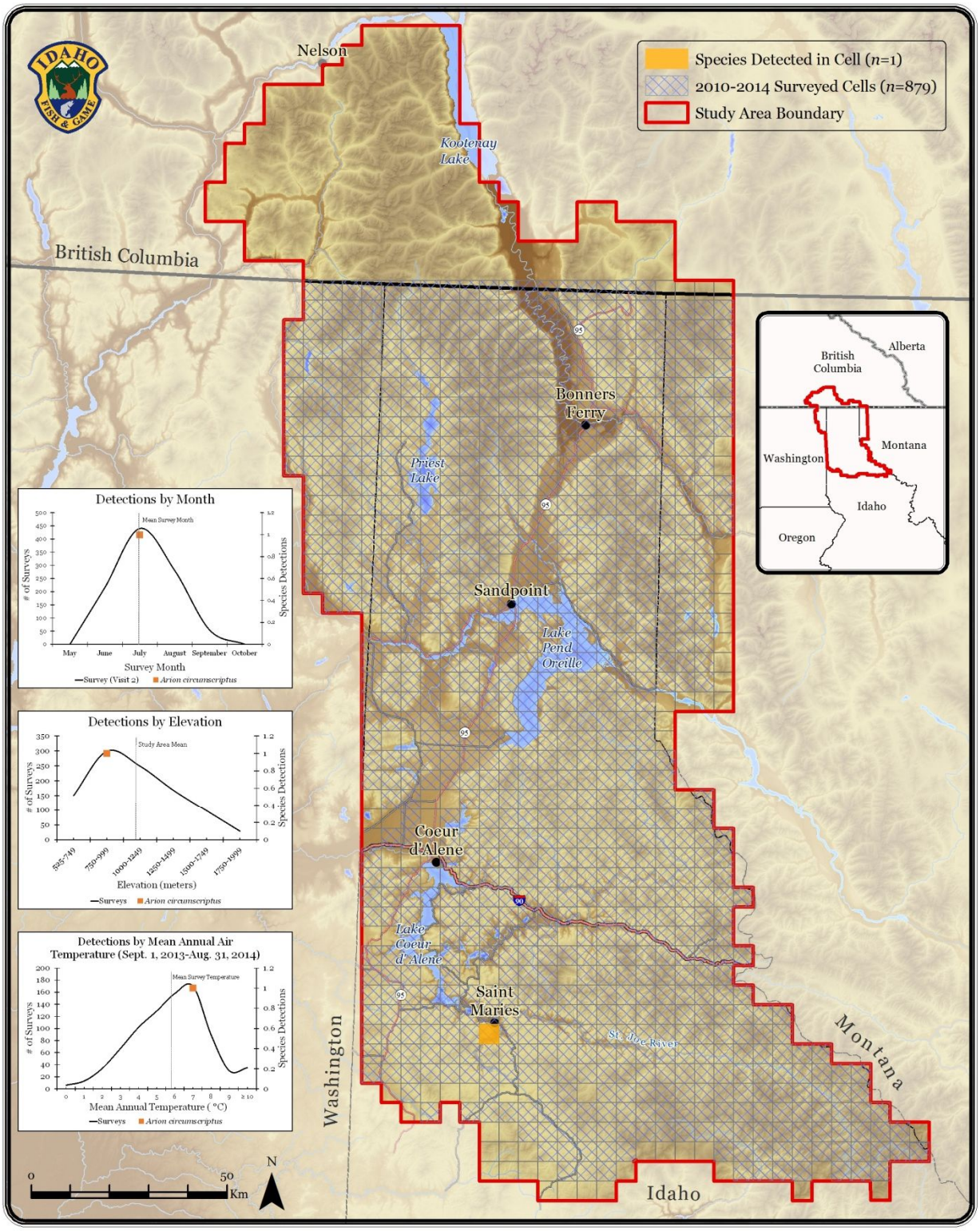
Map 2-7.

Multi-species Baseline Initiative: Pacific Bananaslug (*Ariolimax columbianus*) Detections



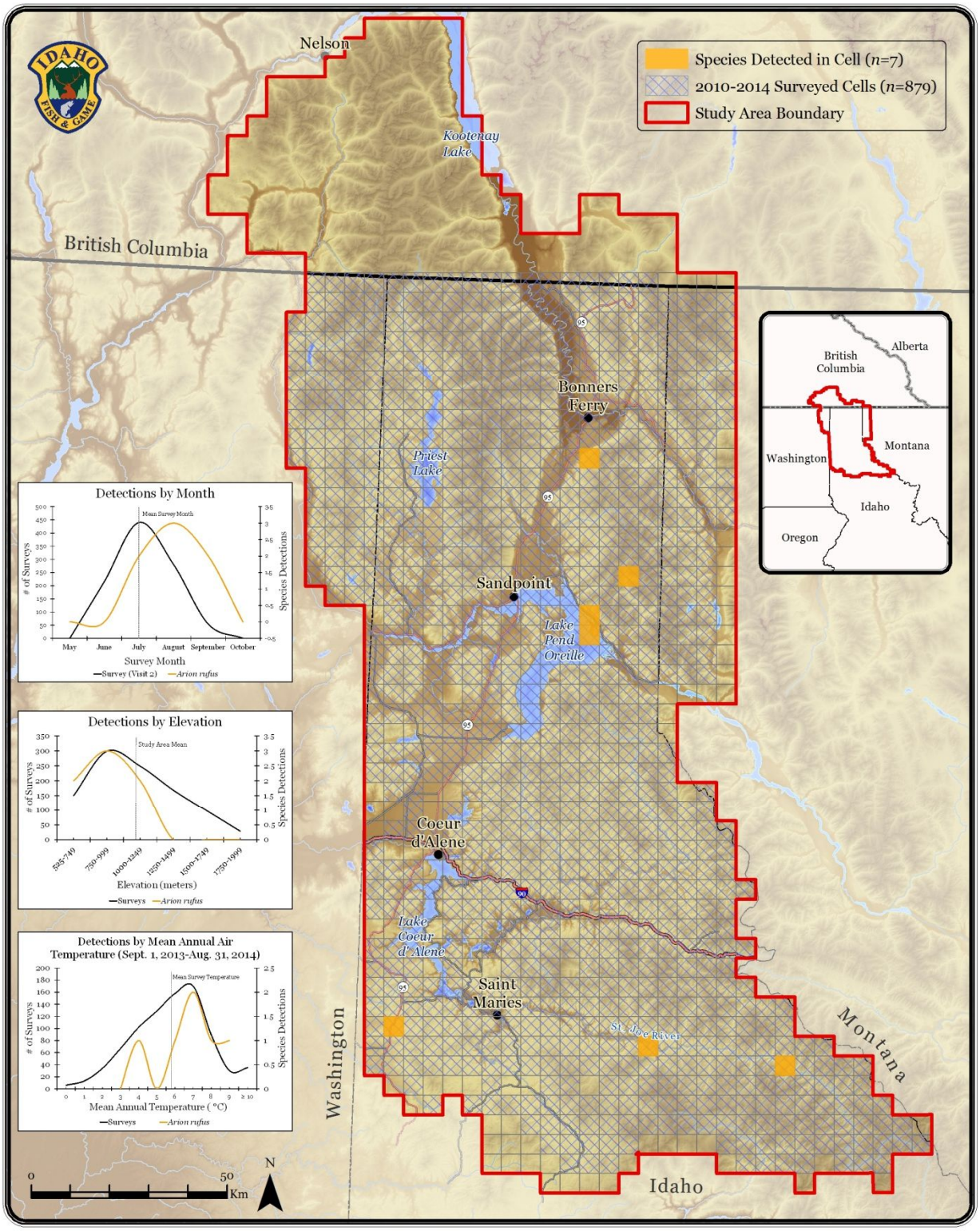
Map 2-8.

Multi-species Baseline Initiative: Brown-banded Arion (*Arion circumscriptus*) Detections



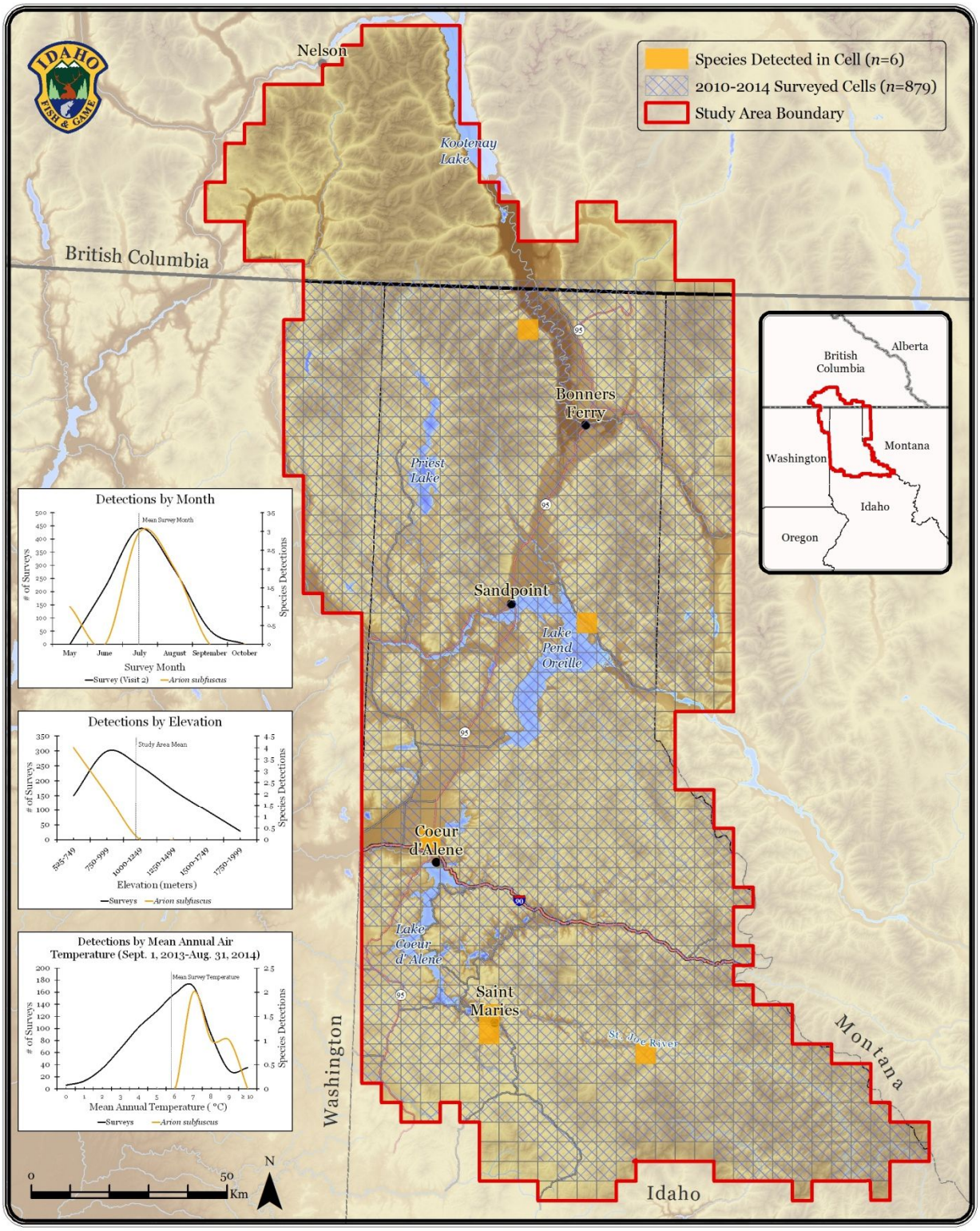
Map 2-9.

Multi-species Baseline Initiative: Chocolate Arion (*Arion rufus*) Detections



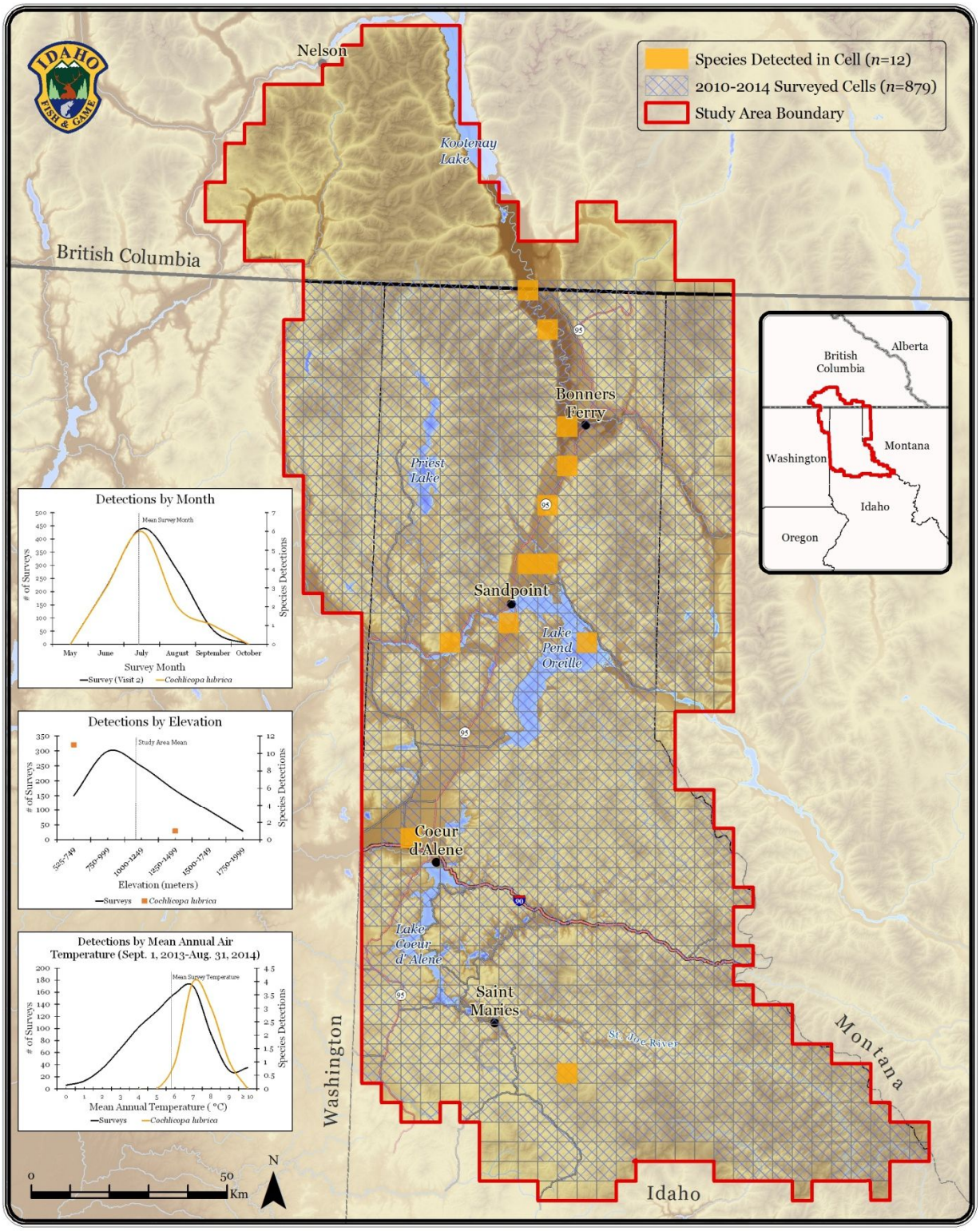
Map 2-10.

Multi-species Baseline Initiative: Dusky Arion (*Arion subfuscus*) Detections



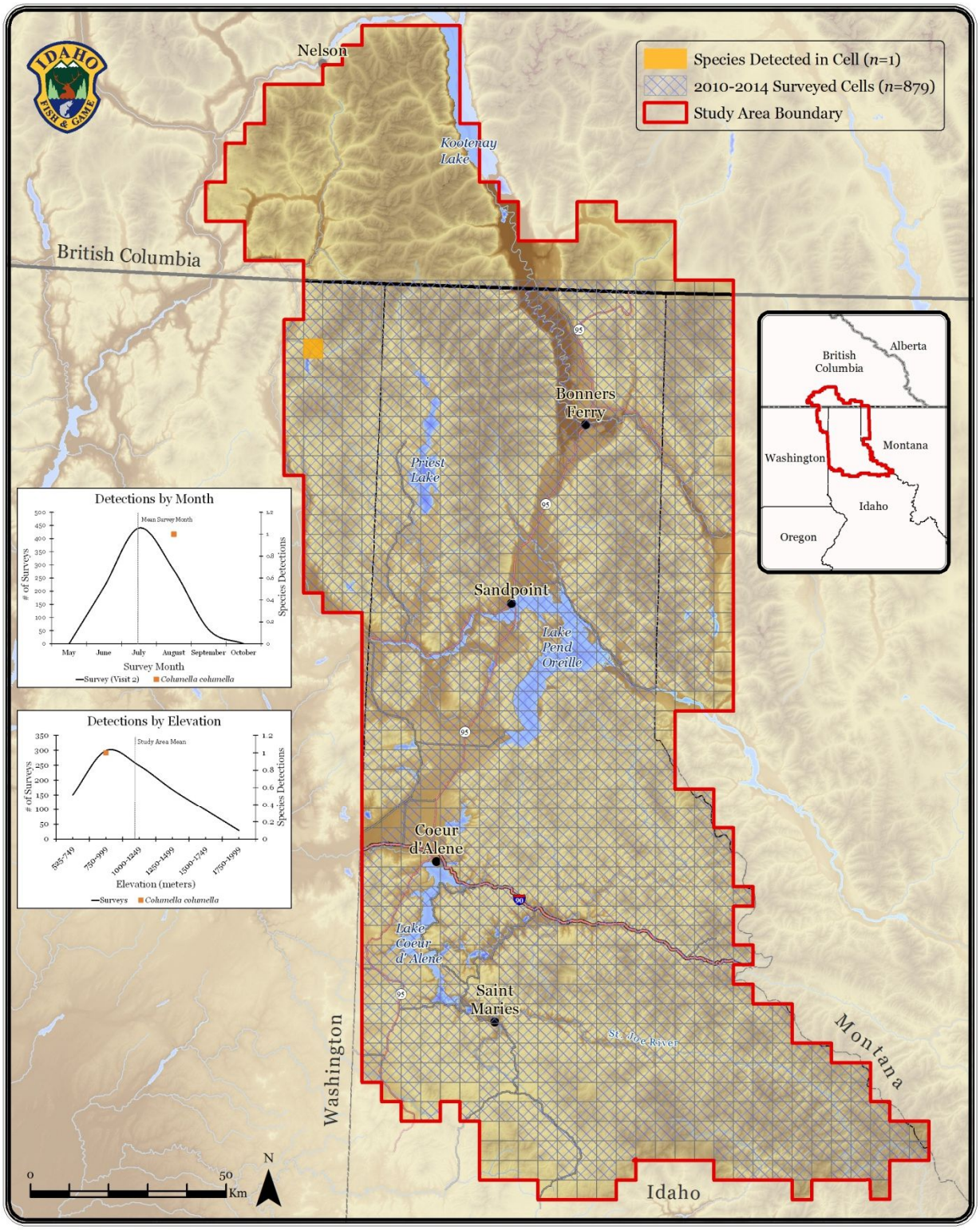
Map 2-11.

Multi-species Baseline Initiative: Glossy Pillar (*Cochlicopa lubrica*) Detections



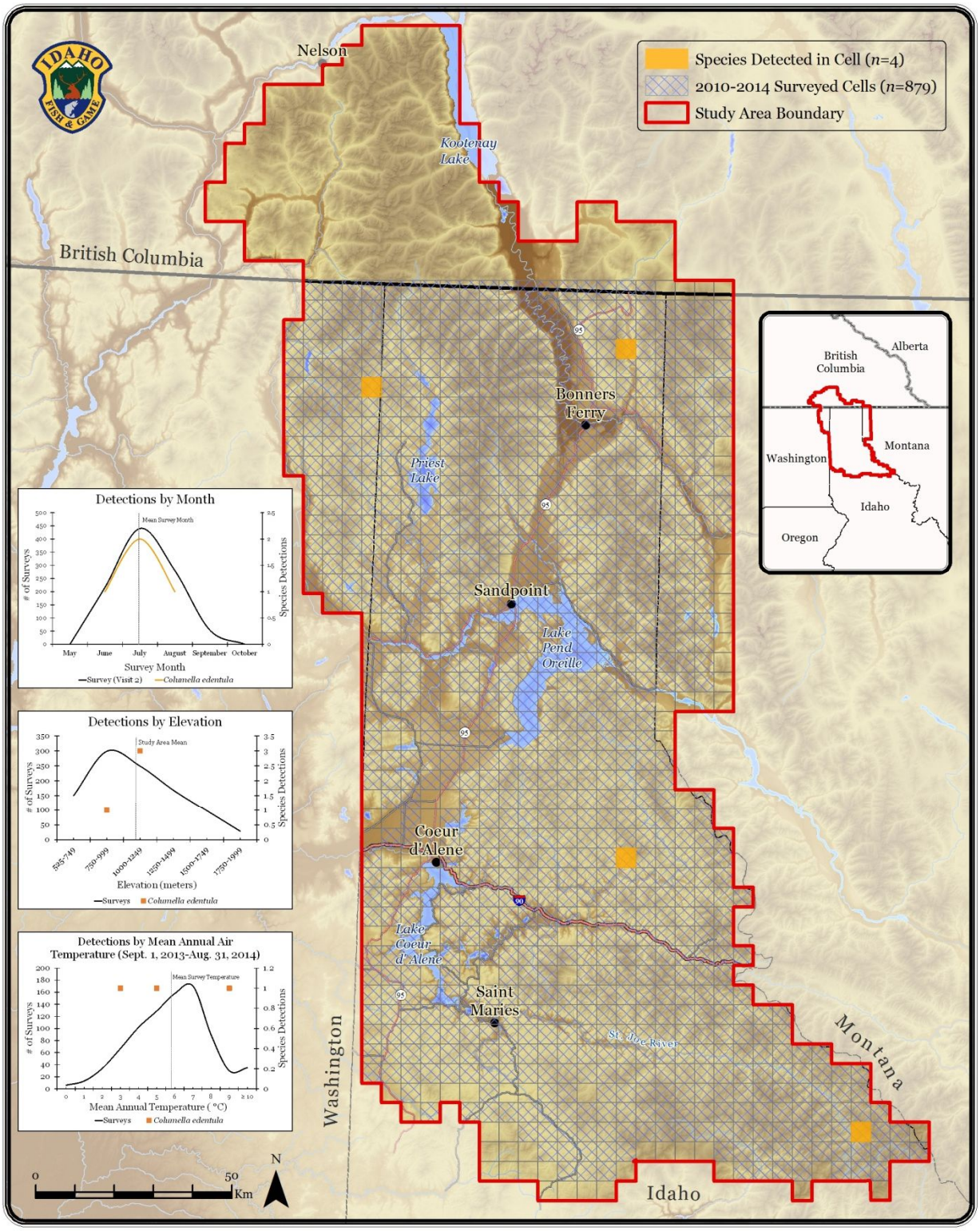
Map 2-12.

Multi-species Baseline Initiative: *Columella columella* Detections



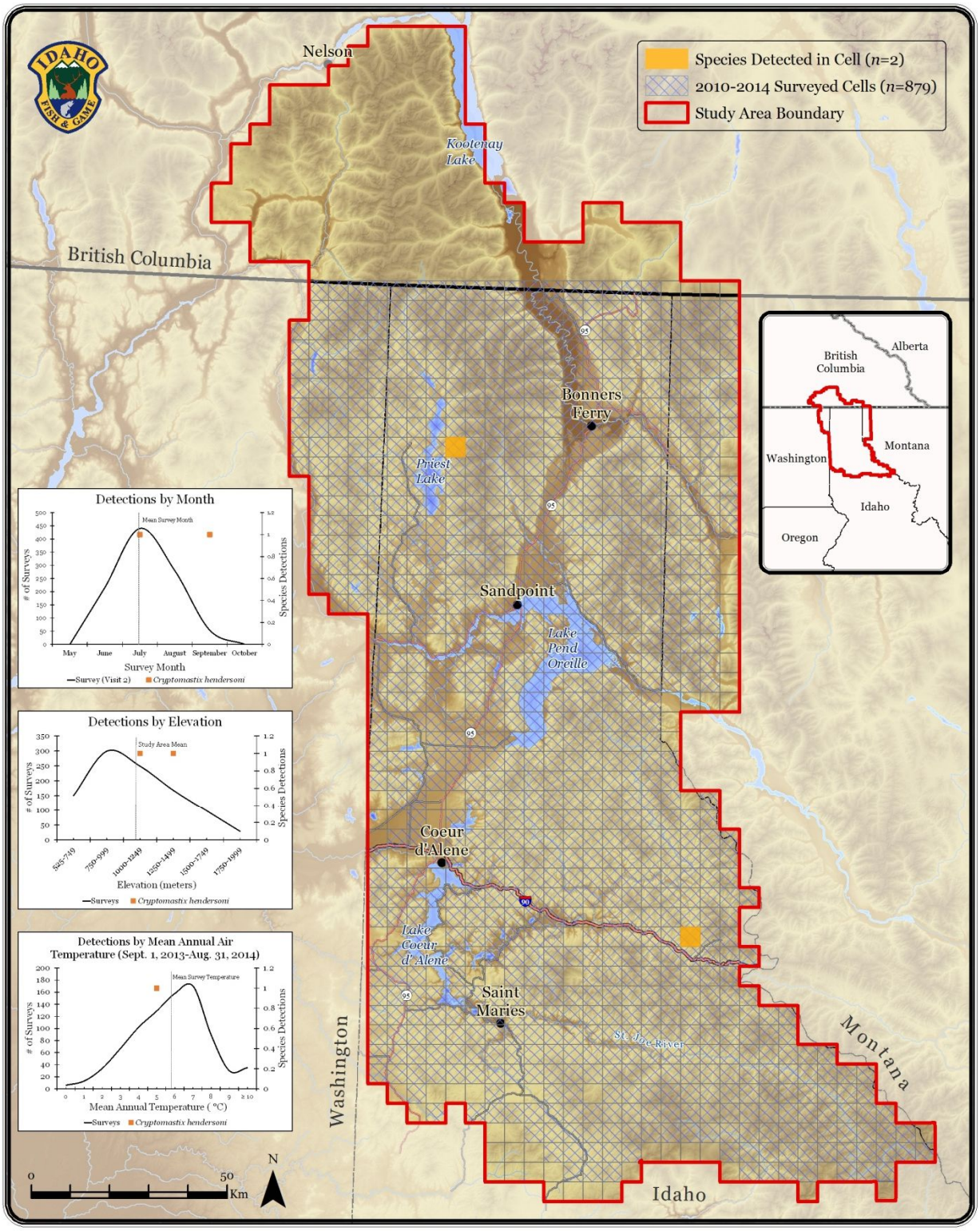
Map 2-13.

Multi-species Baseline Initiative: Toothless Column snail (*Columella edentula*) Detections



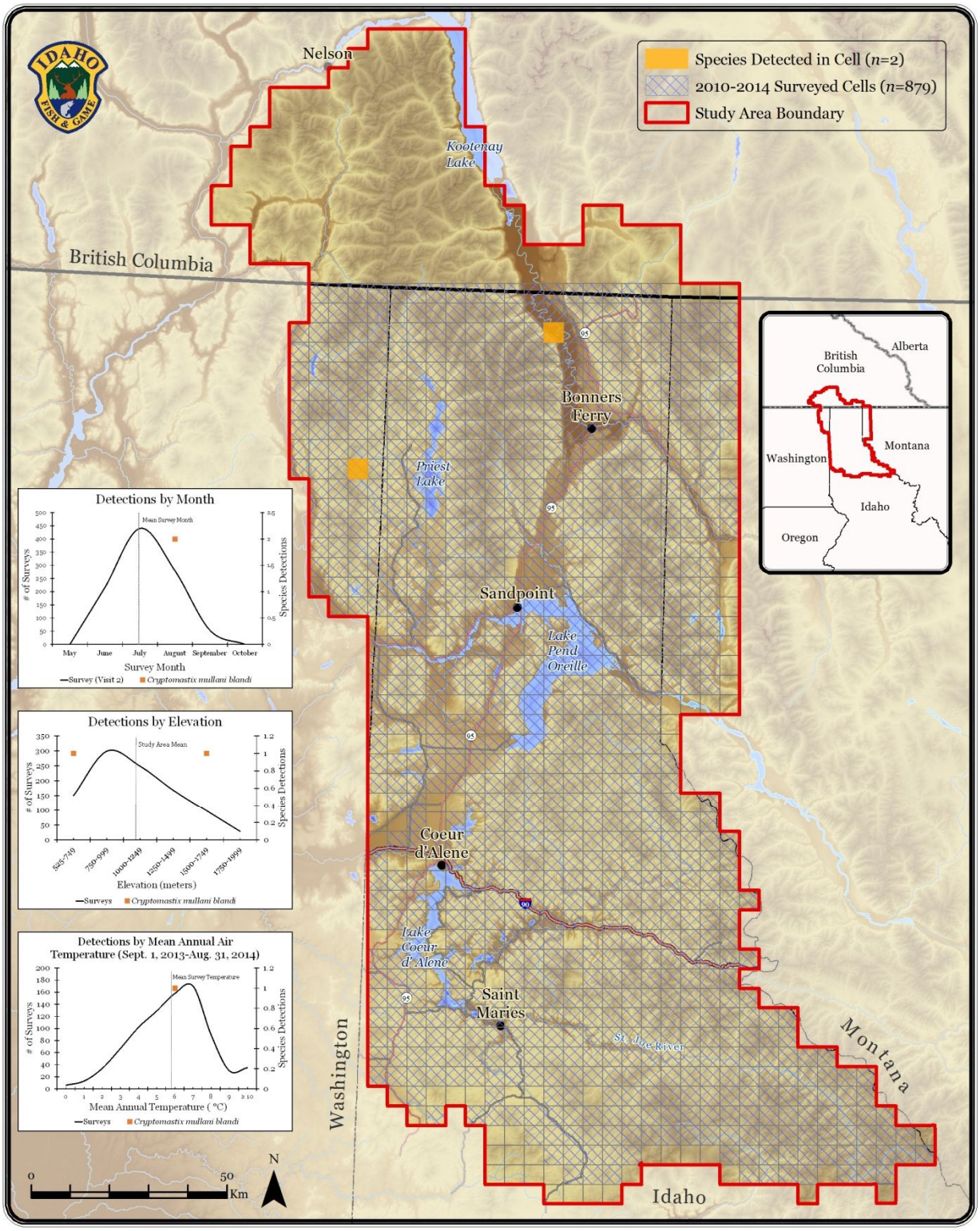
Map 2-14.

Multi-species Baseline Initiative: Columbia Oregonian (*Cryptomastix hendersoni*) Detections



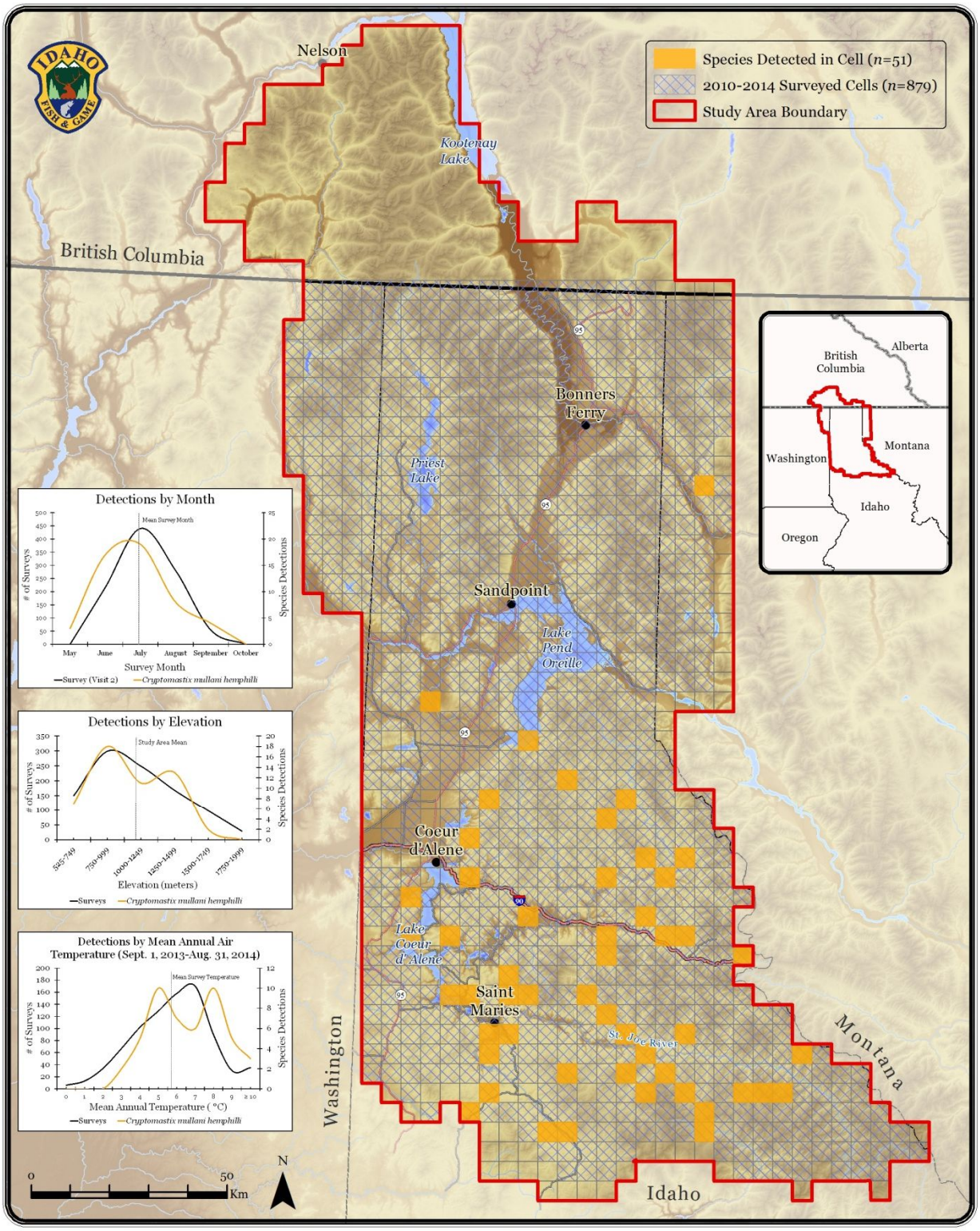
Map 2-15.

Multi-species Baseline Initiative: *Cryptomastix mullani blandi* Detections



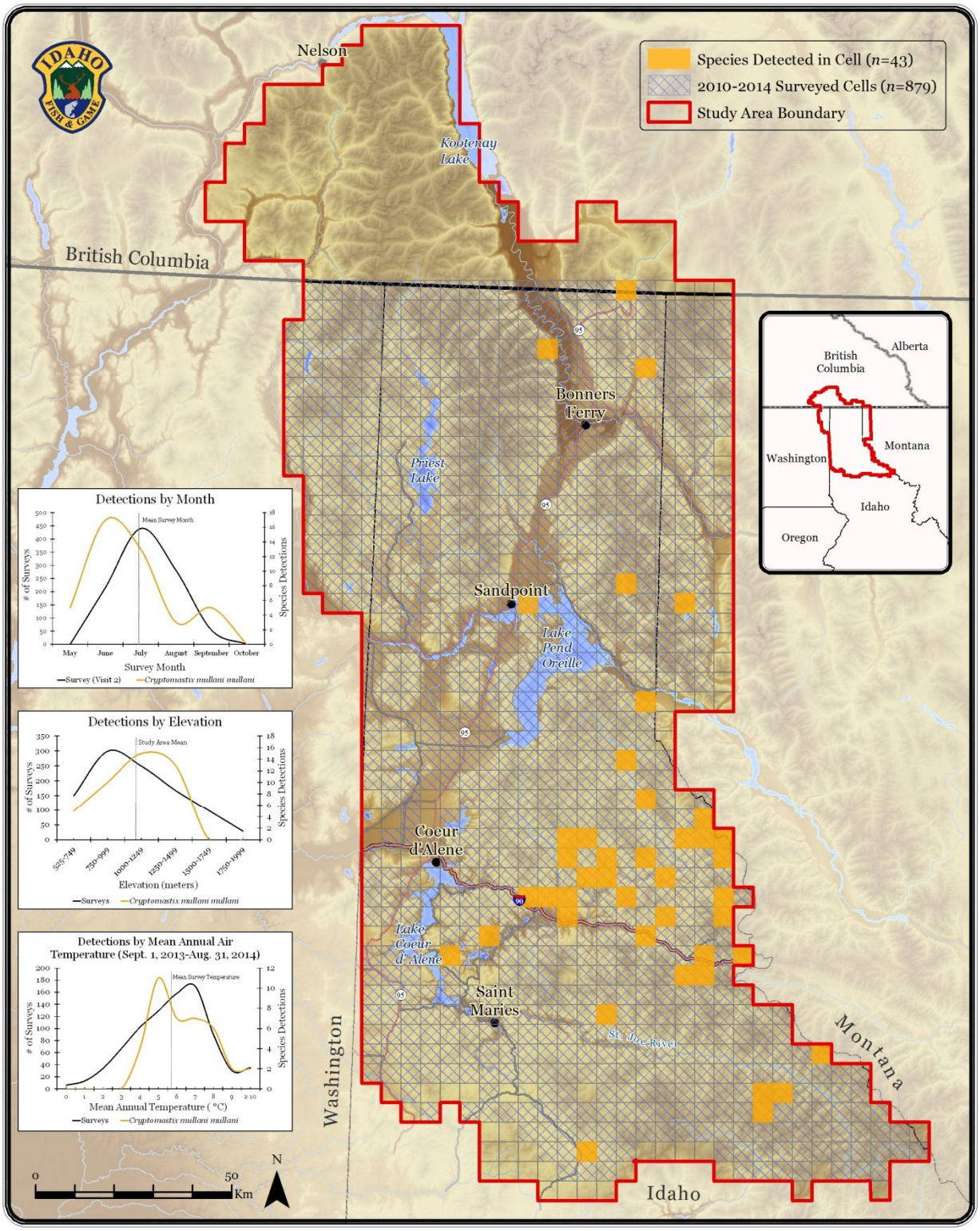
Map 2-16.

Multi-species Baseline Initiative: *Cryptomastix mullani hemphilli* Detections



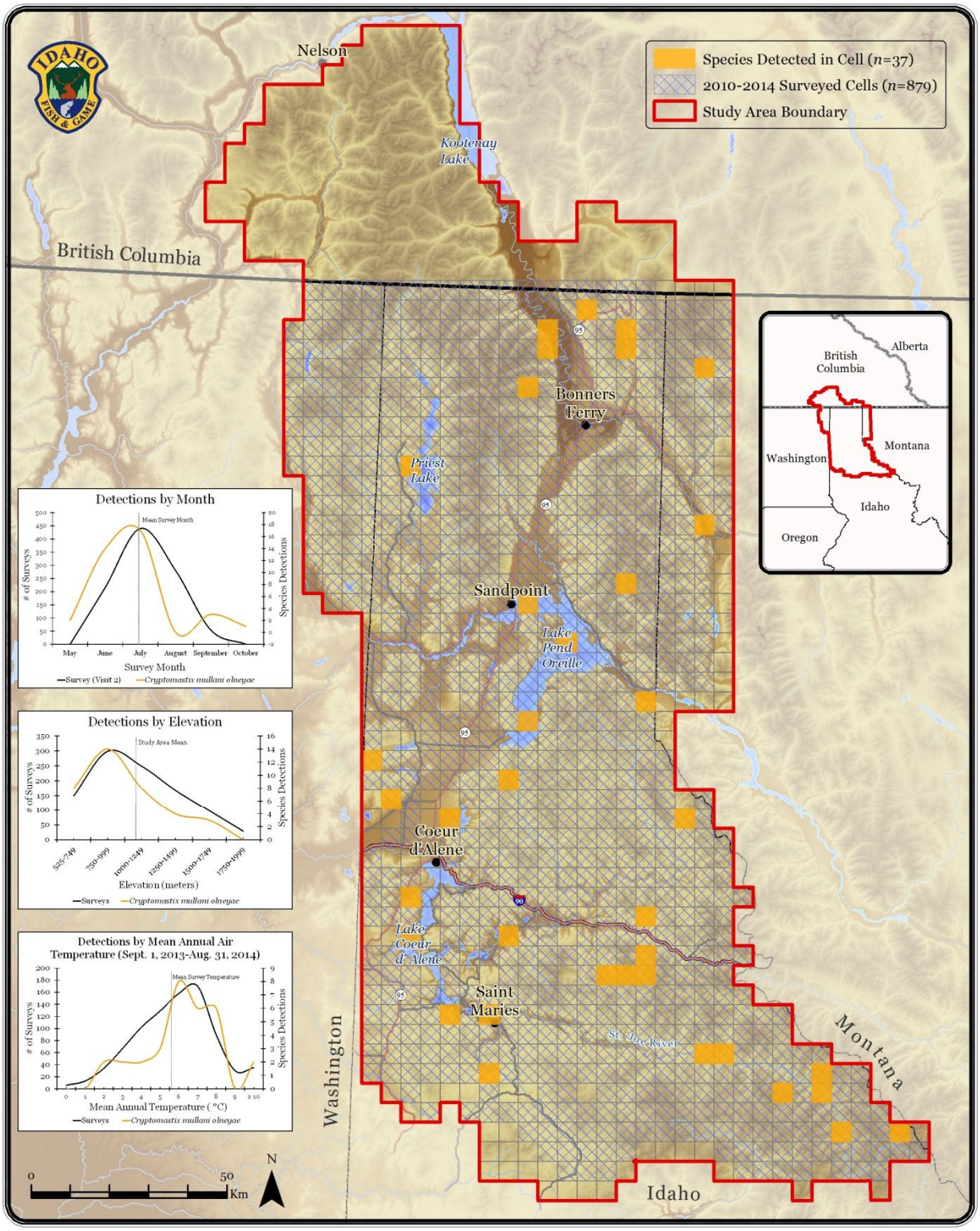
Map 2-17.

Multi-species Baseline Initiative: Coeur d' Alene Oregonian (*Cryptomastix mullani mullani*) Detections

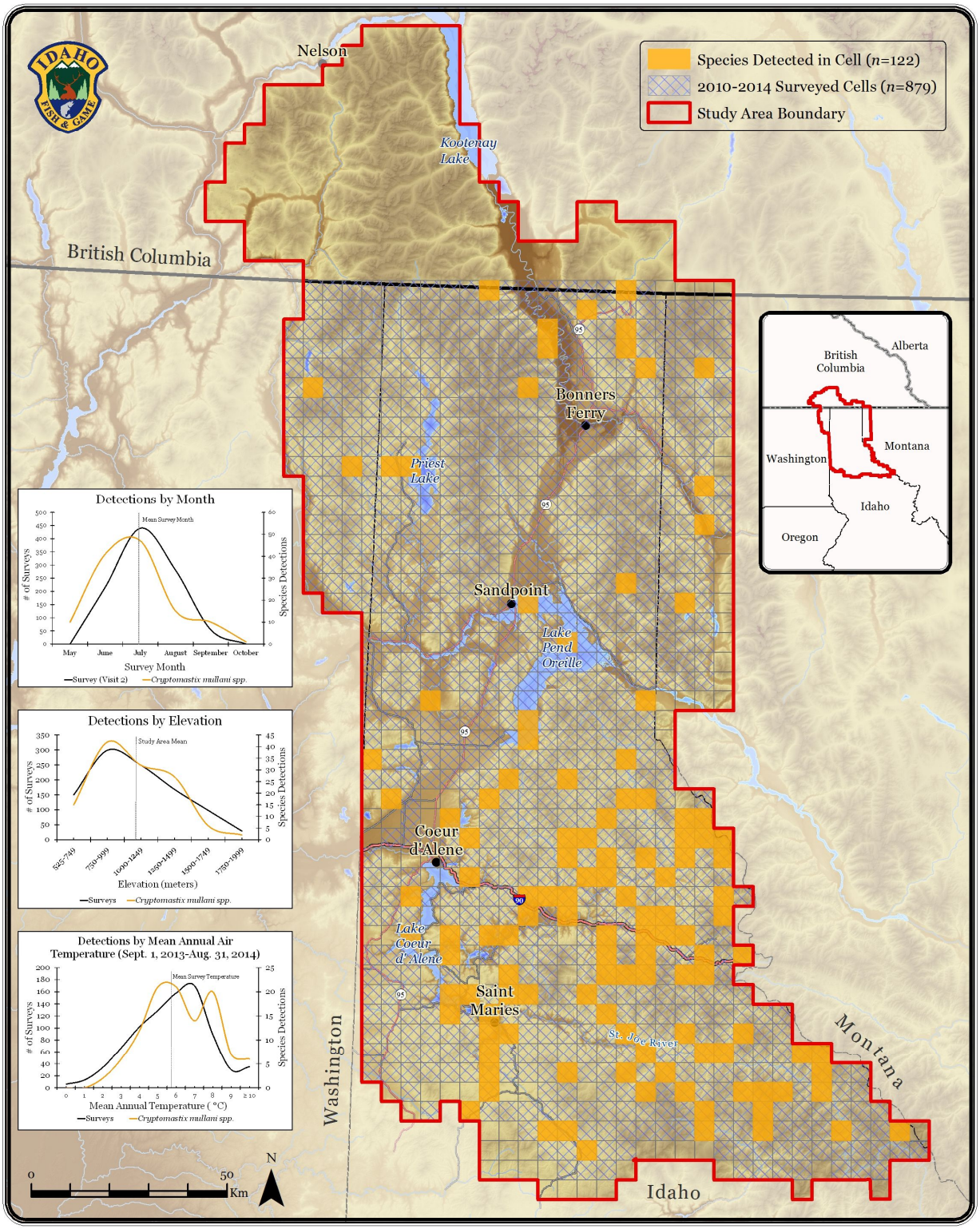


Map 2-18.

Multi-species Baseline Initiative: *Cryptomastix mullani olneyae* Detections

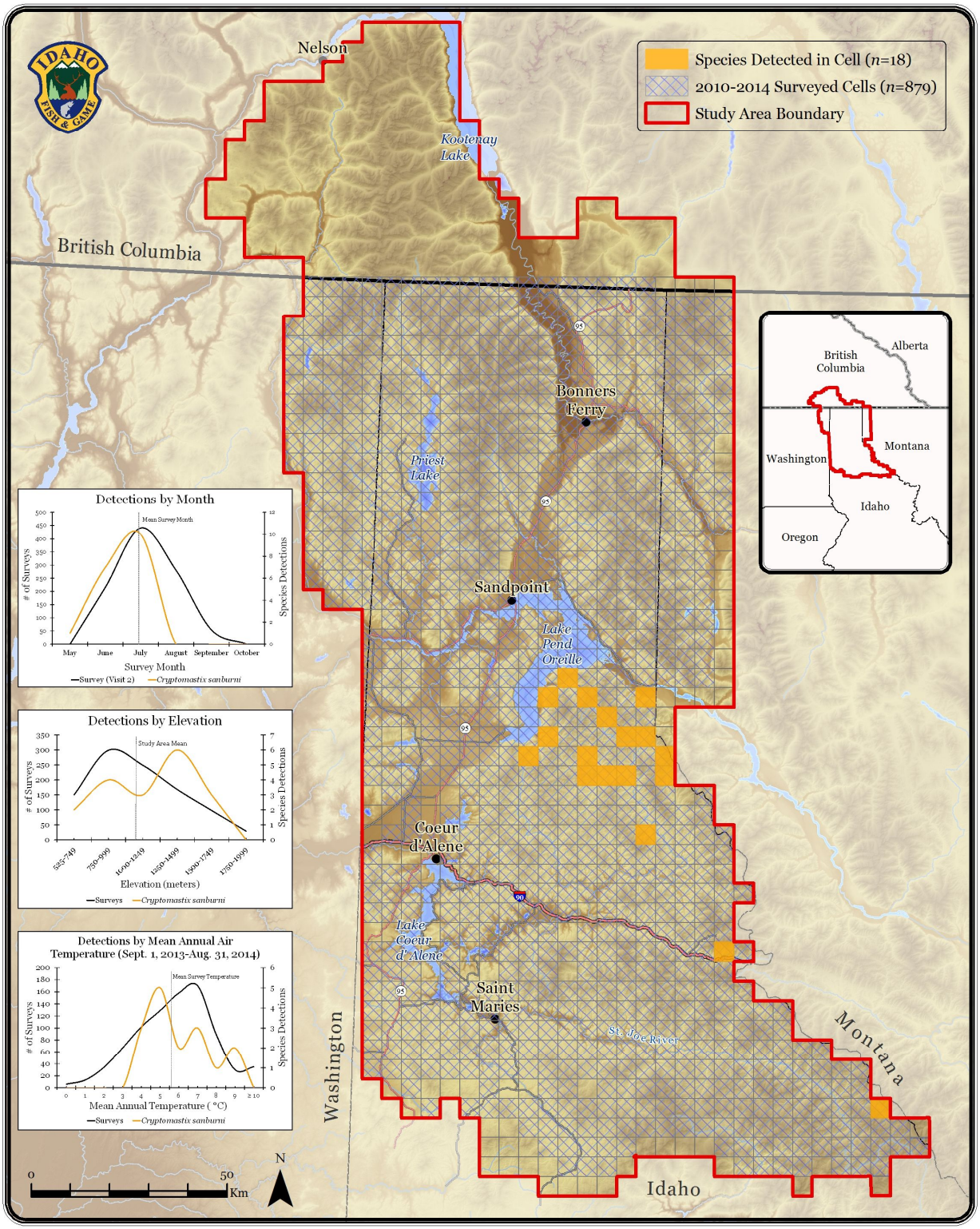


Map 2-19.



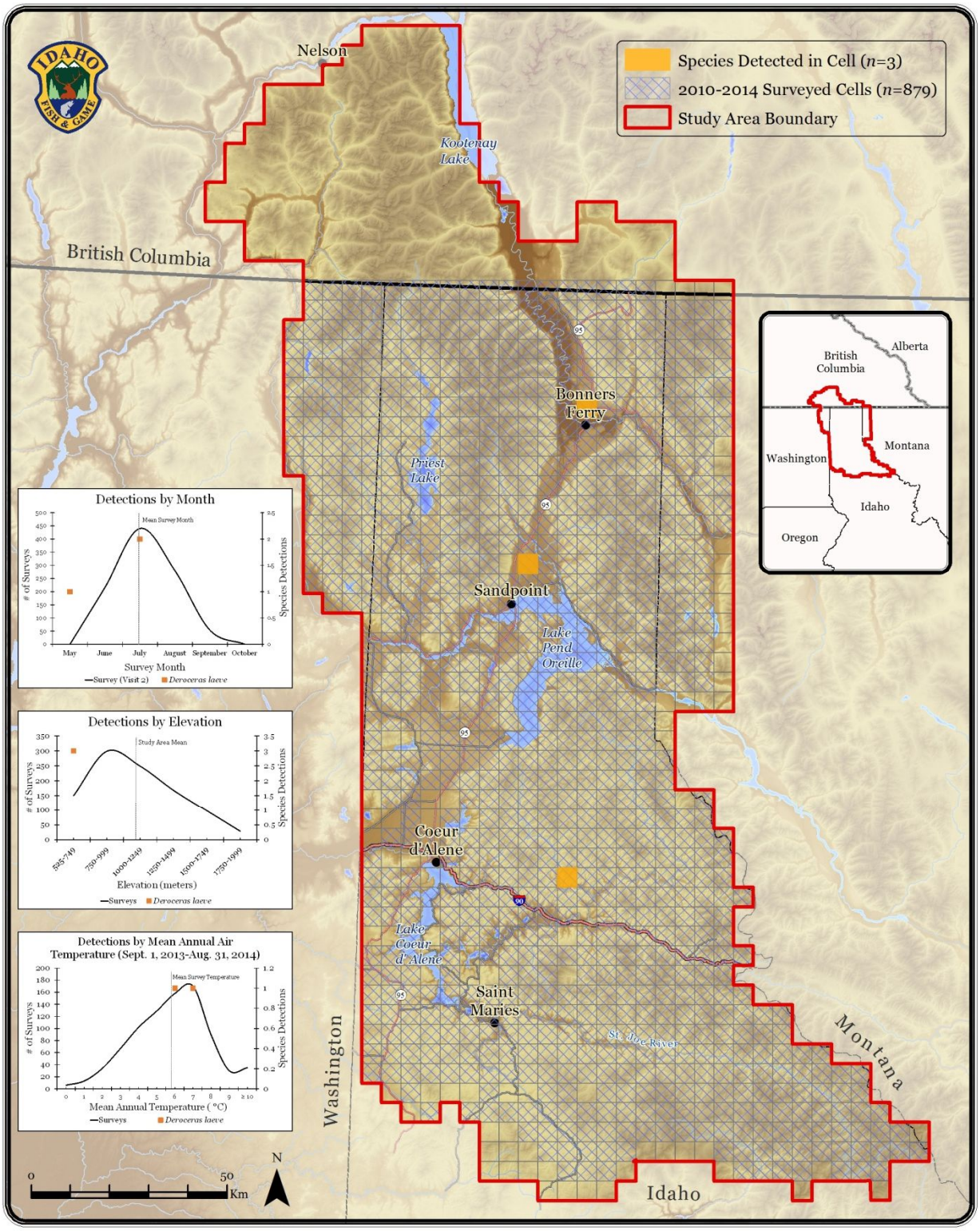
Map 2-20. All *C. mullani* detections including all subspecies.

Multi-species Baseline Initiative: Kingston Oregonian (*Cryptomastix sanburni*) Detections



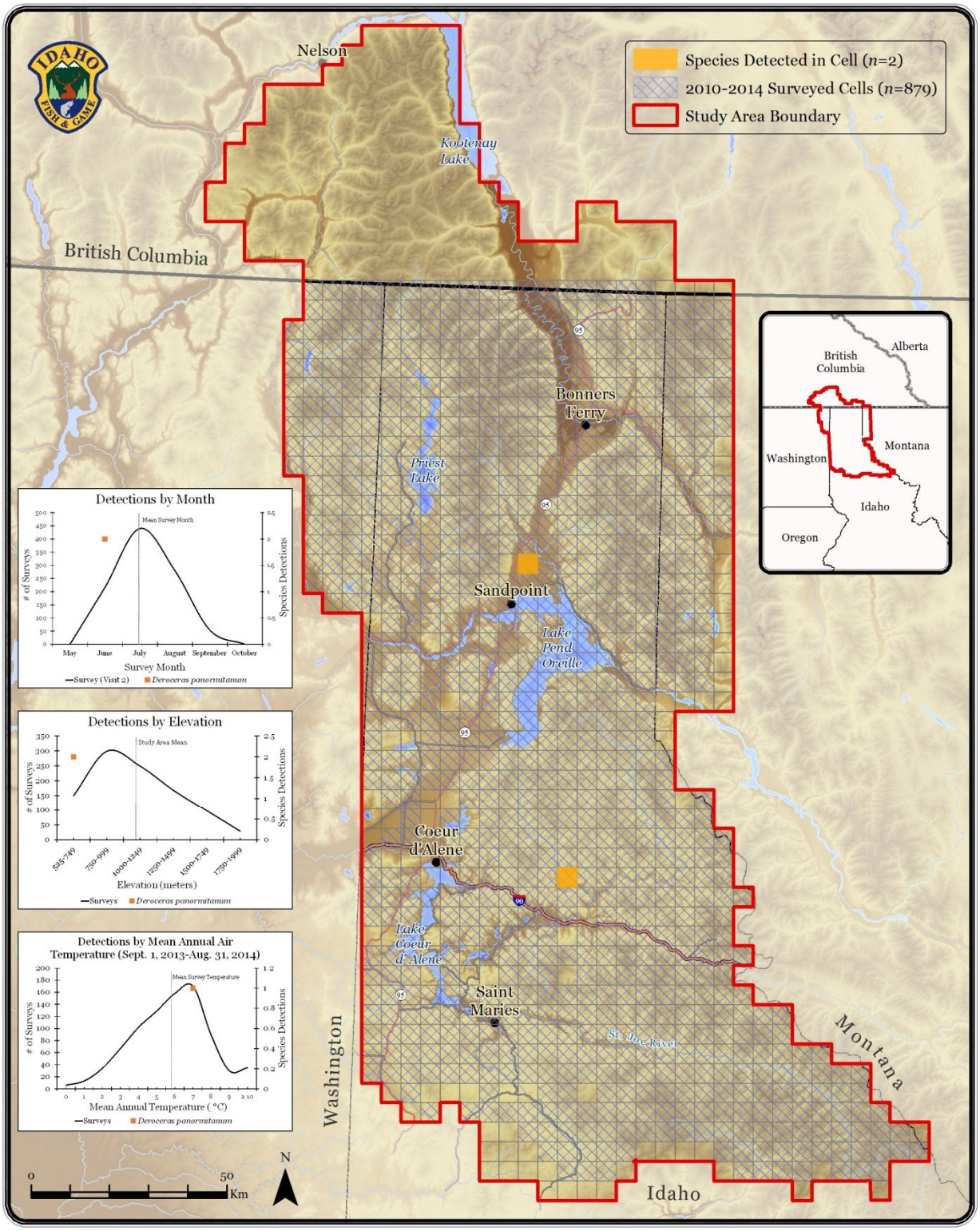
Map 2-21.

Multi-species Baseline Initiative: Meadow Fieldslug (*Deroceras laeve*) Detections



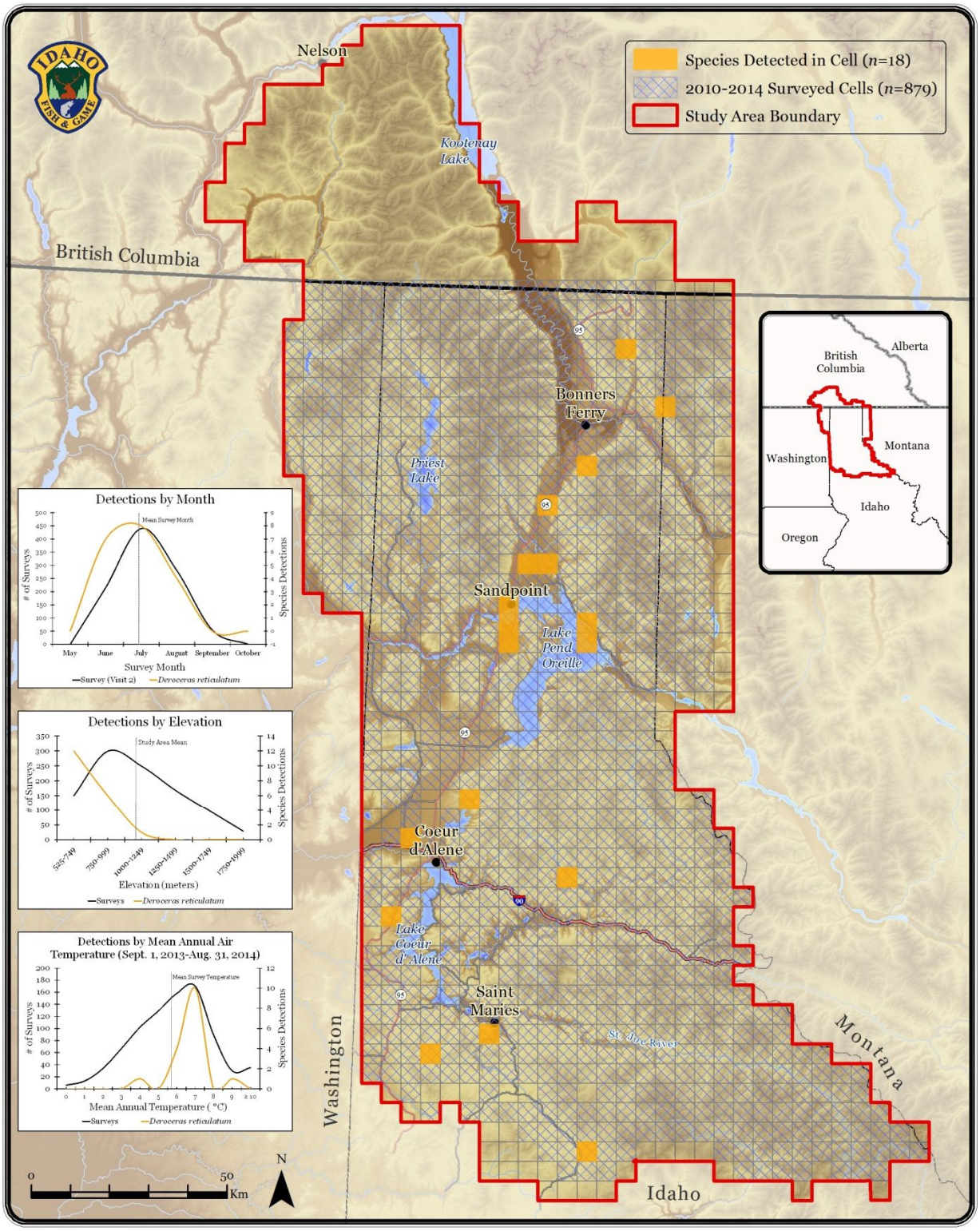
Map 2-22.

Multi-species Baseline Initiative: Longneck Fieldslug (*Deroceras panormitanum*) Detections



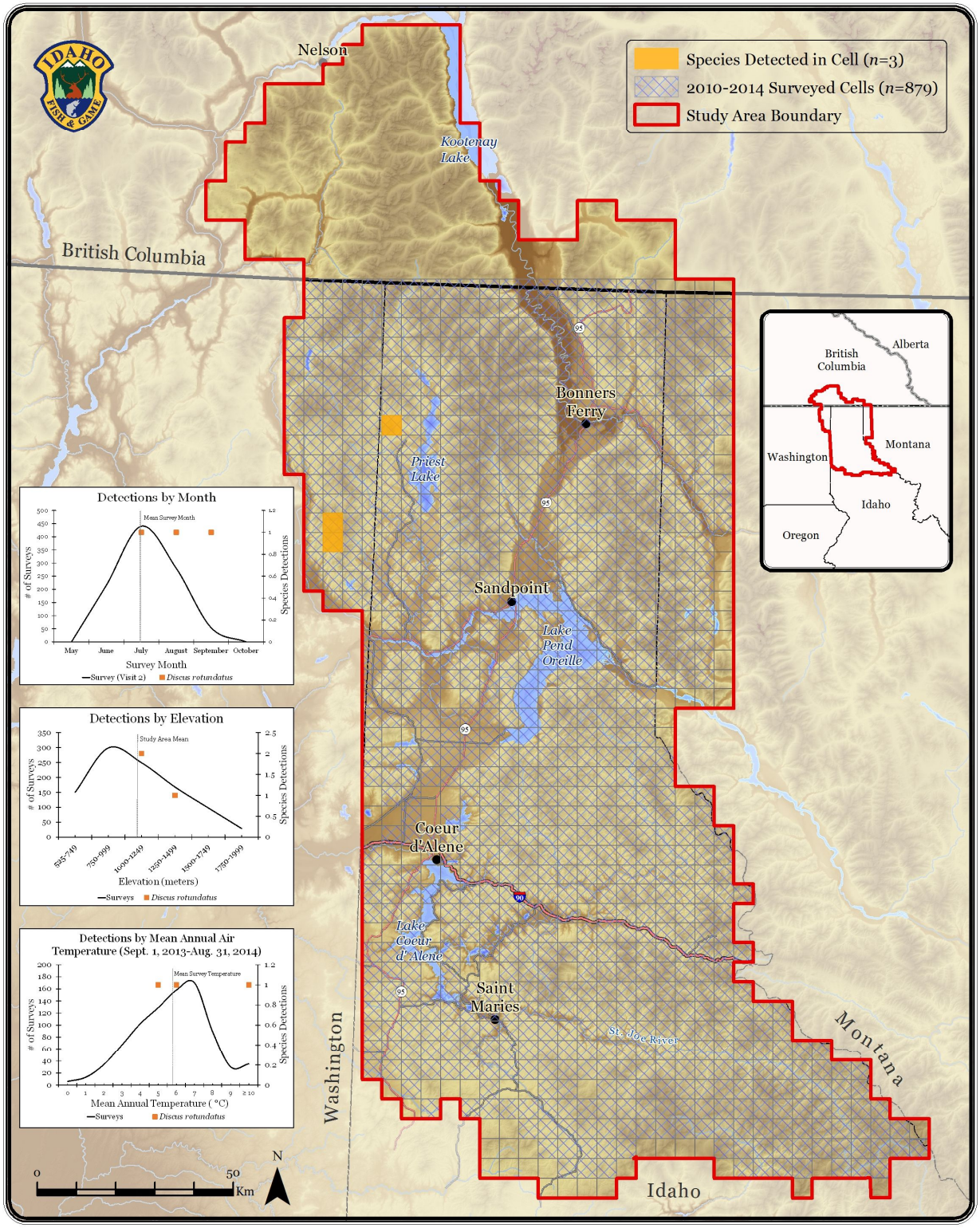
Map 2-23.

Multi-species Baseline Initiative: Gray Fieldslug (*Deroceras reticulatum*) Detections



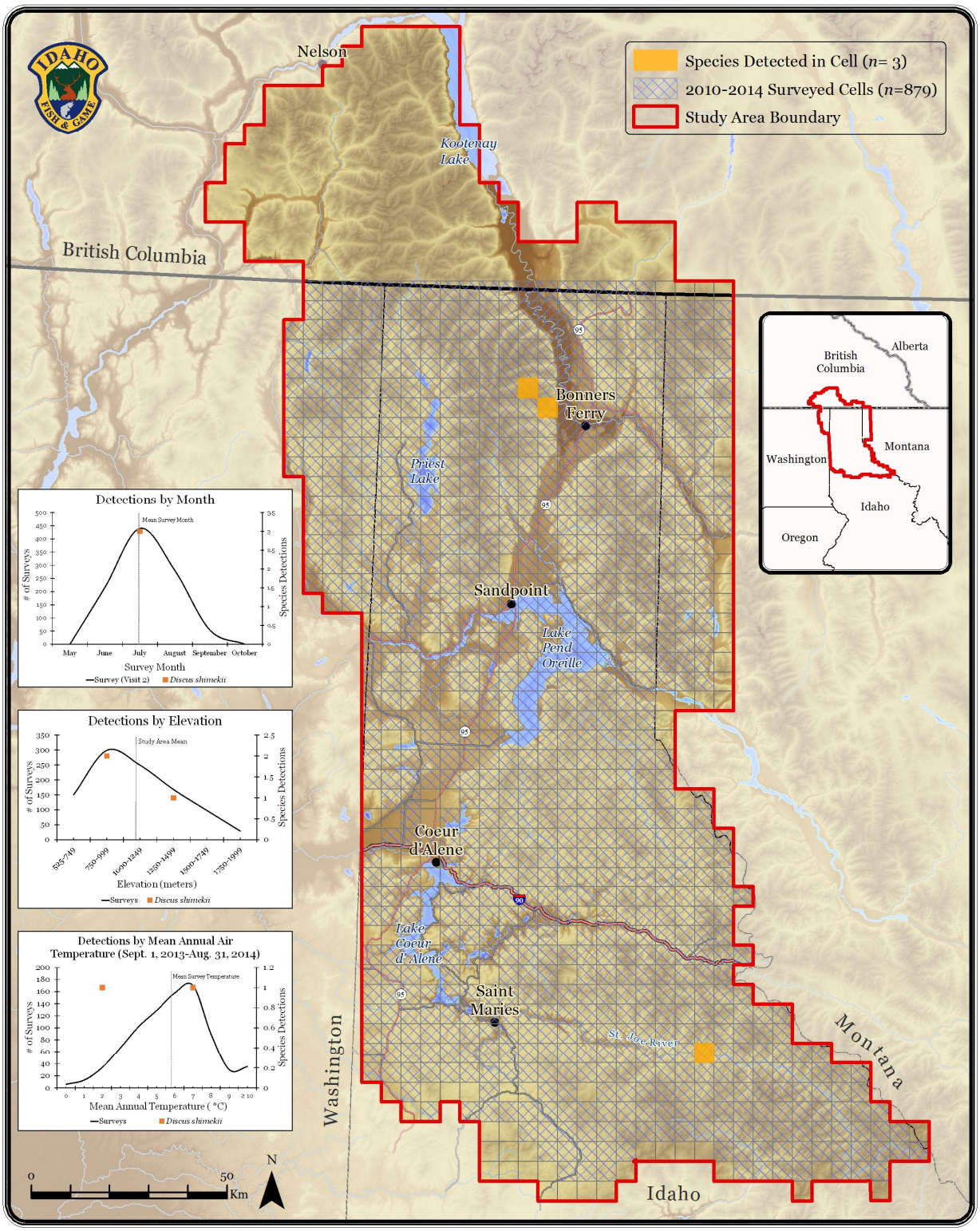
Map 2-24.

Multi-species Baseline Initiative: Rotund Disc (*Discus rotundatus*) Detections



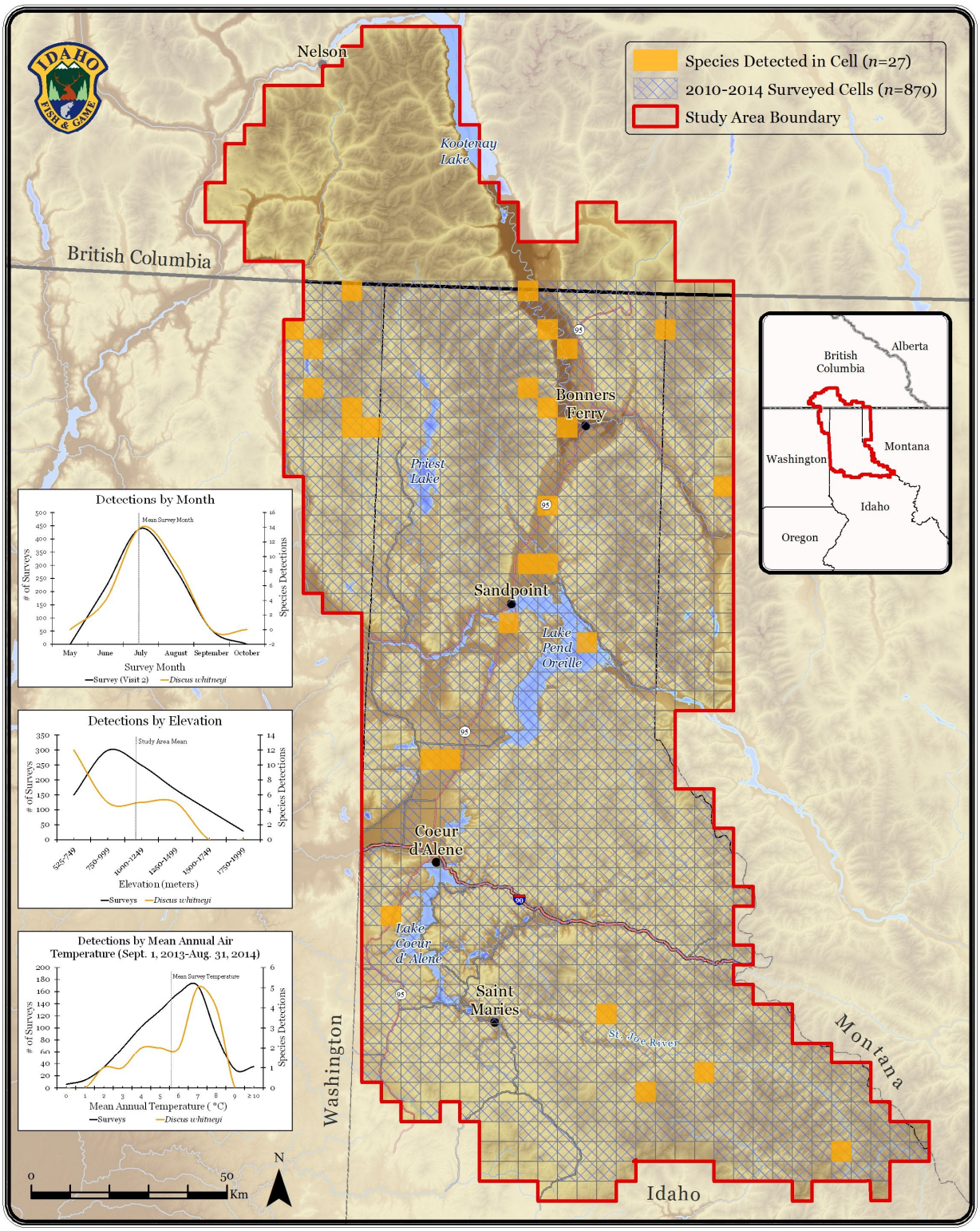
Map 2-25.

Multi-species Baseline Initiative: Striate Disc (*Discus shimekii*) Detections



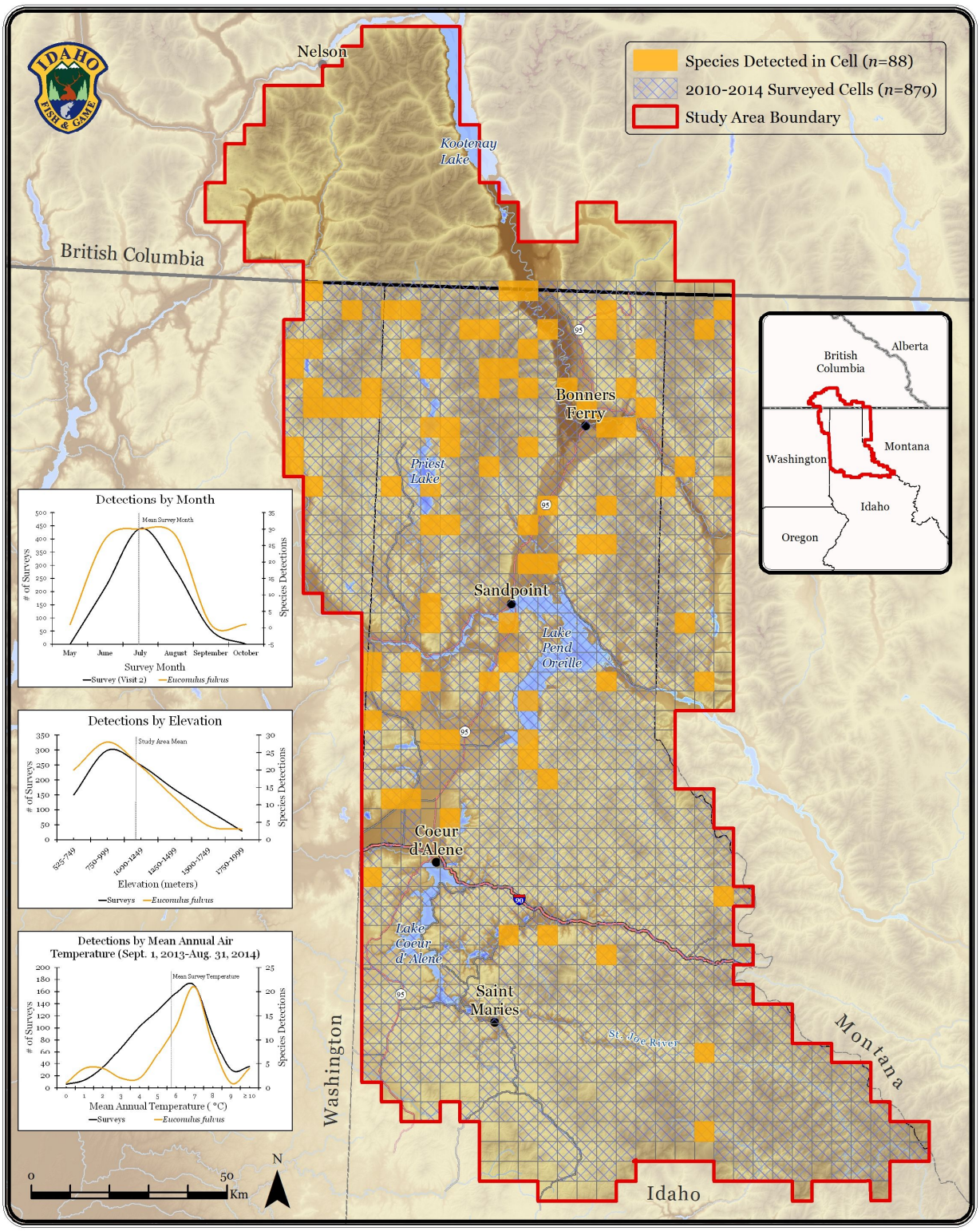
Map 2-26.

Multi-species Baseline Initiative: Forest Disc (*Discus whitneyi*) Detections



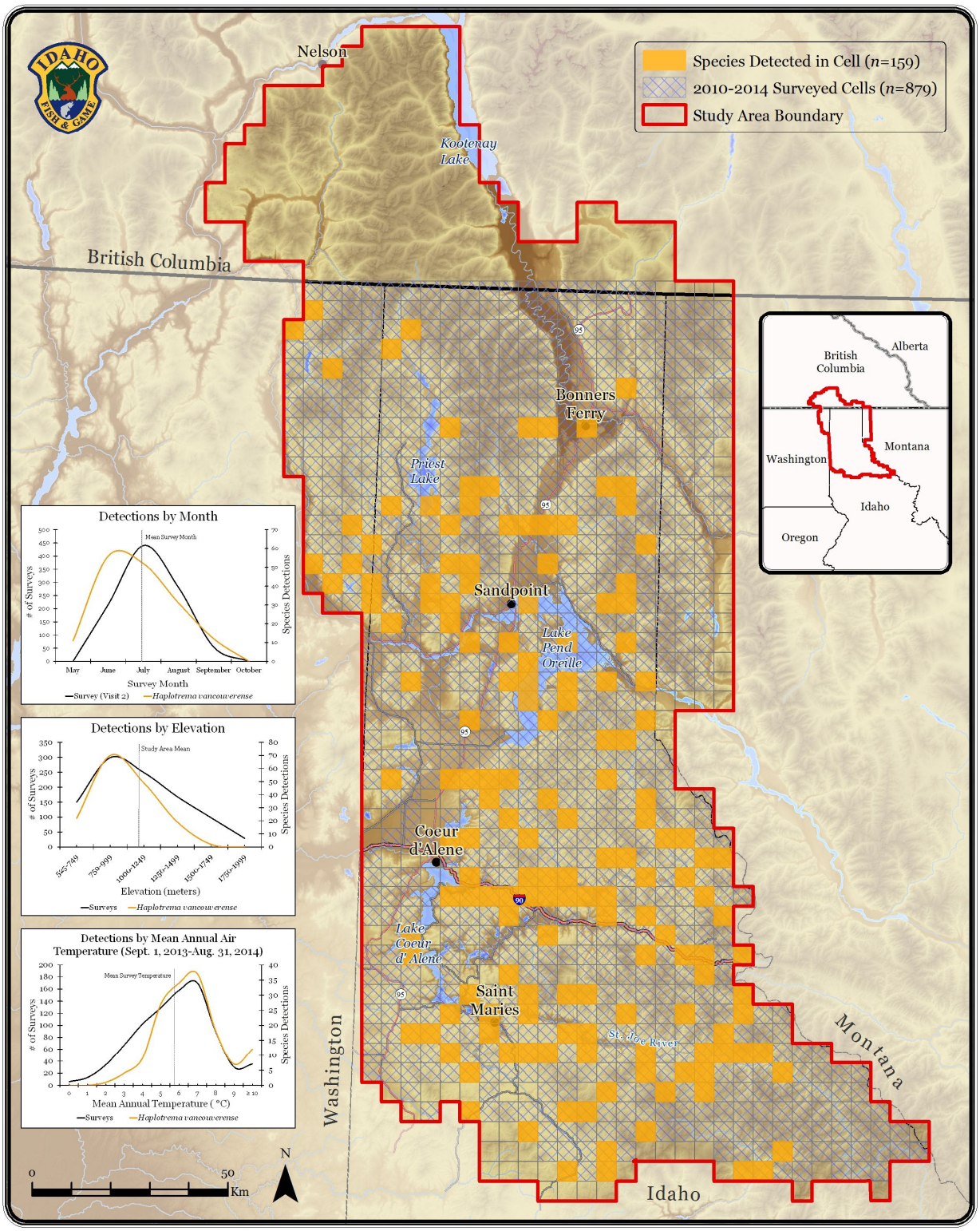
Map 2-27.

Multi-species Baseline Initiative: Brown Hive (*Euconulus fulvus*) Detections



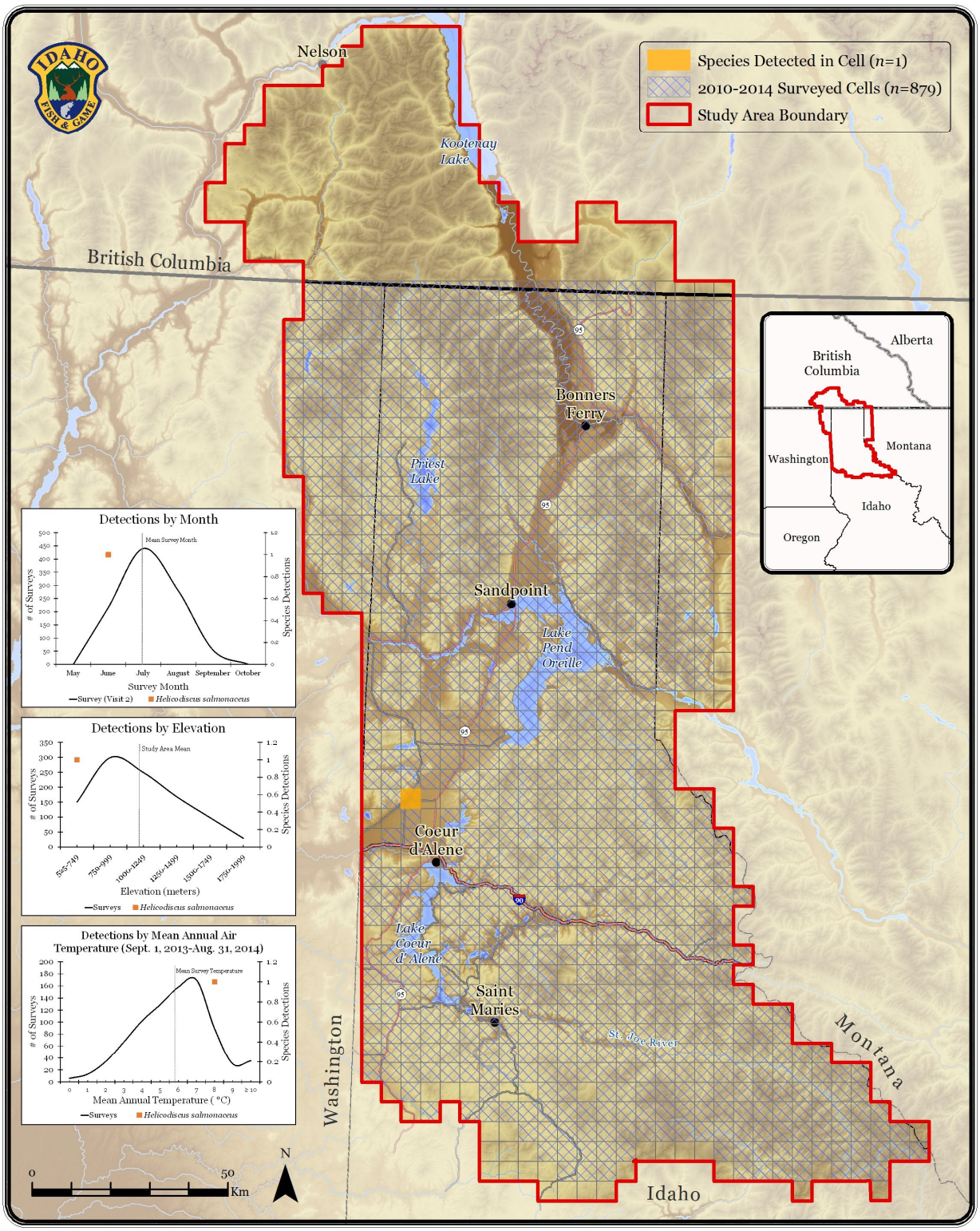
Map 2-28.

Multi-species Baseline Initiative: Robust Lancetooth (*Haplotrema vancouverense*) Detections



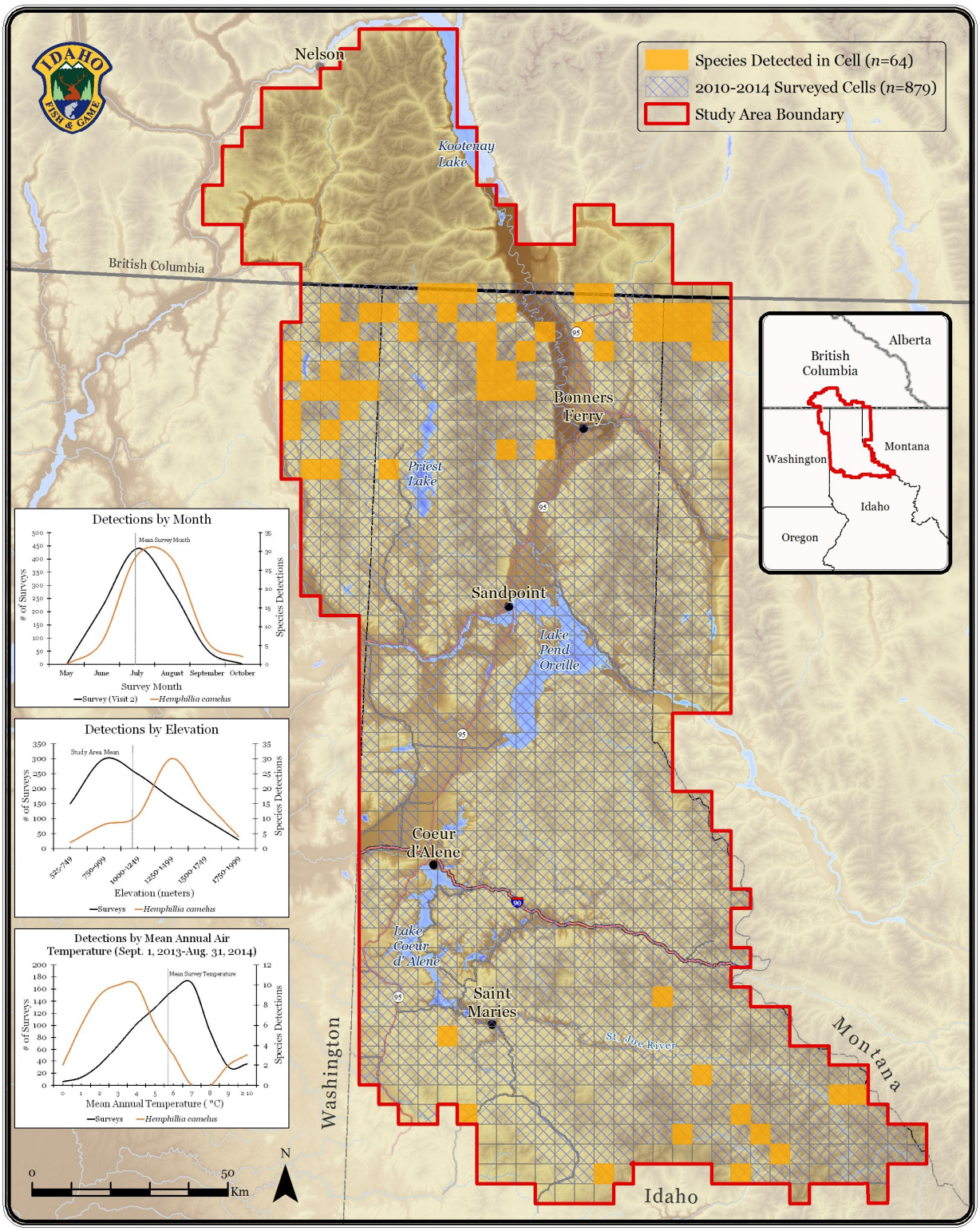
Map 2-29.

Multi-species Baseline Initiative: Salmon Coil (*Helicodiscus salmonaceus*) Detections



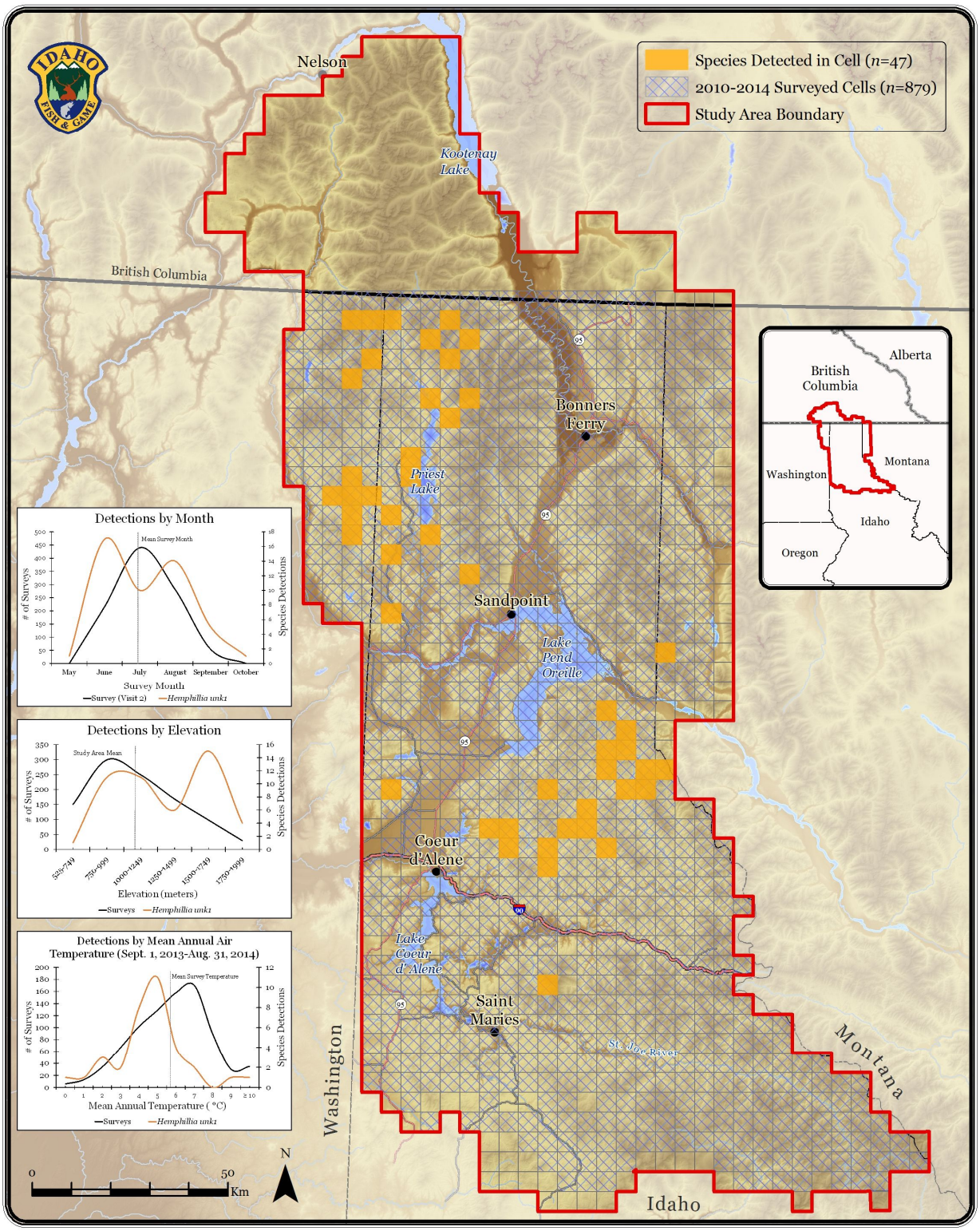
Map 2-30.

Multi-species Baseline Initiative: Pale Jumping-slug (*Hemphillia camelus*) Detections



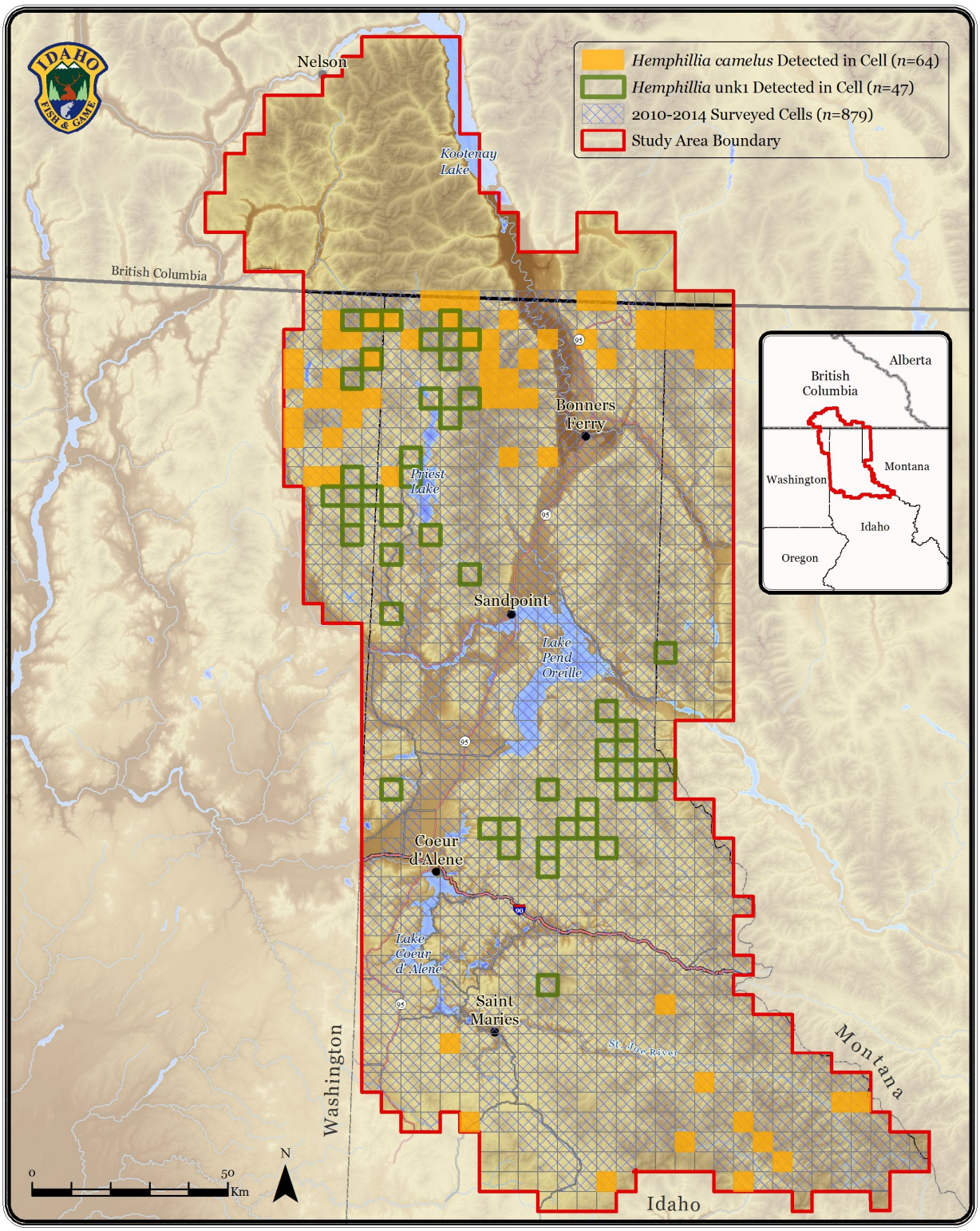
Map 2-31.

Multi-species Baseline Initiative: *Hemphillia* unk1 Detections



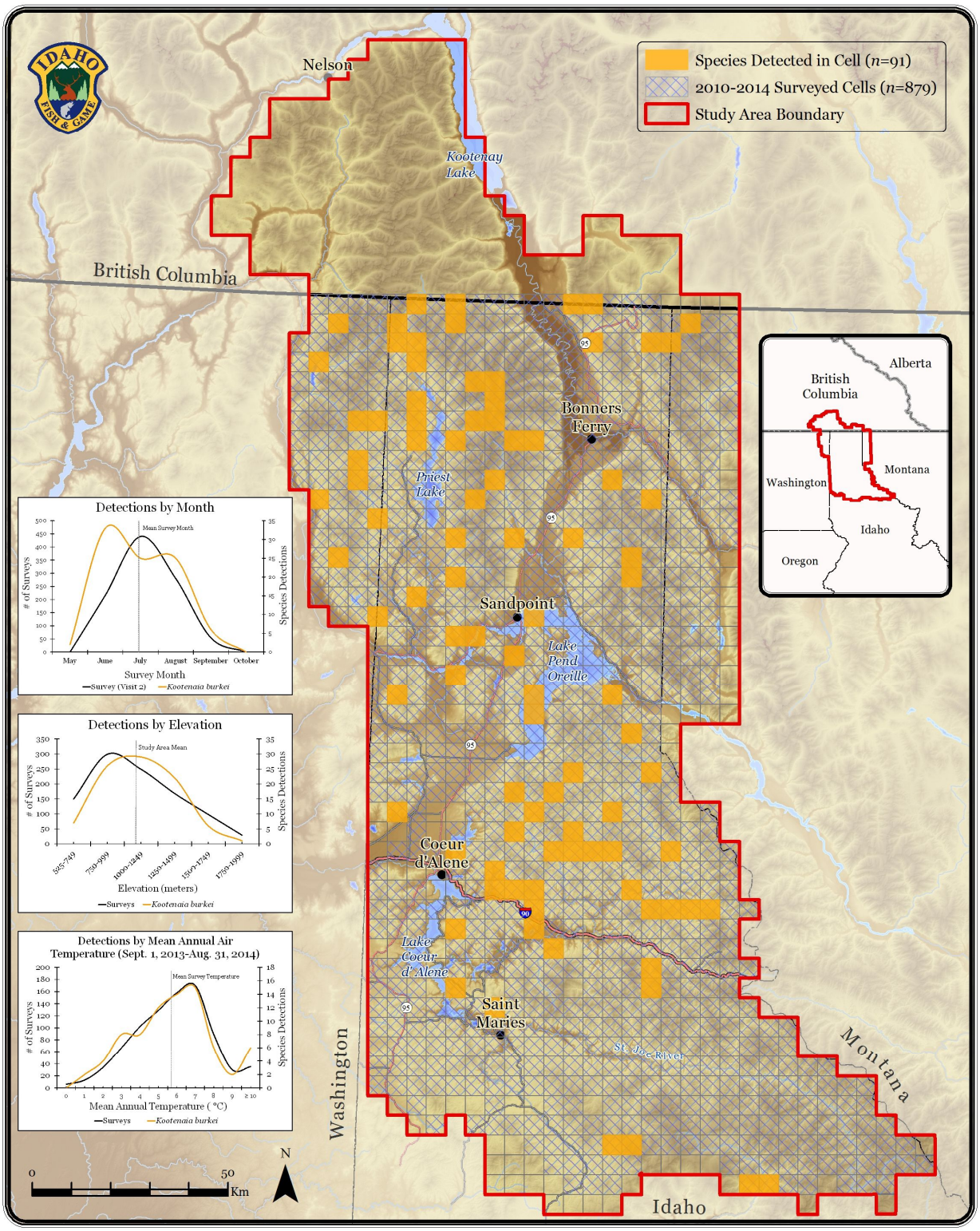
Map 2-32.

Multi-species Baseline Initiative: *Hemphillia* spp. Detections



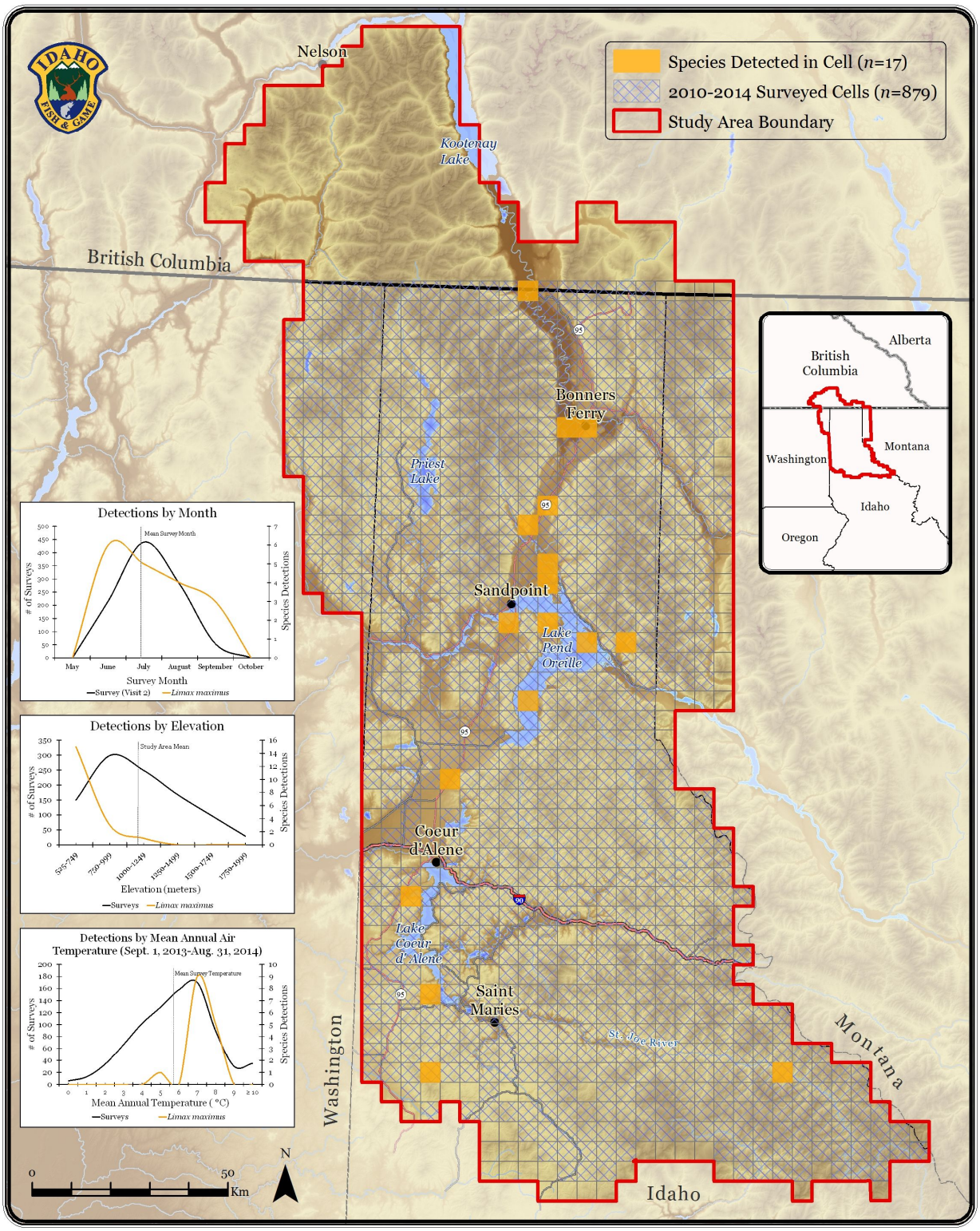
Map 2-33.

Multi-species Baseline Initiative: Pygmy Slug (*Kootenaia burkei*) Detections



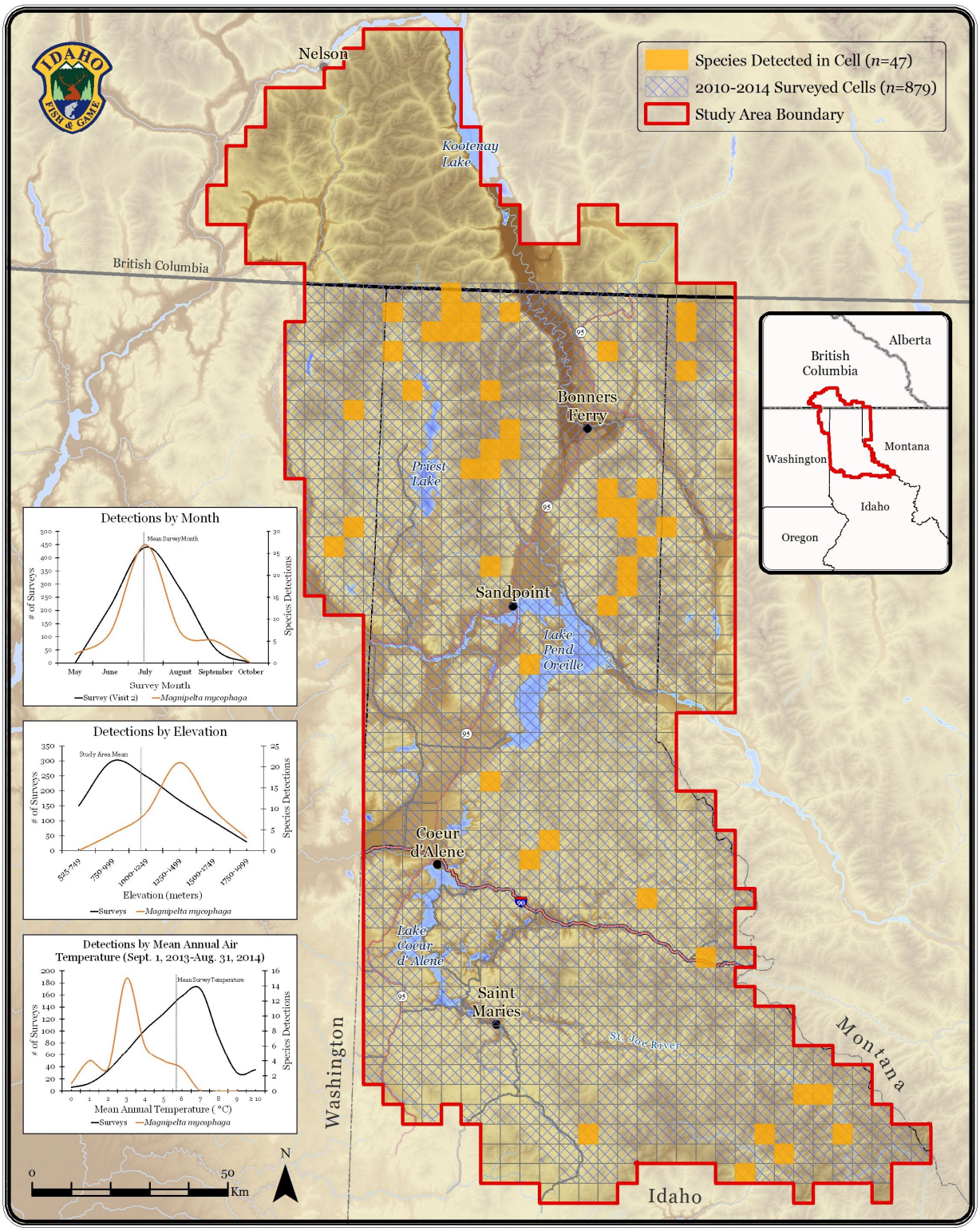
Map 2-34.

Multi-species Baseline Initiative: Giant Gardenslug (*Limax maximus*) Detections



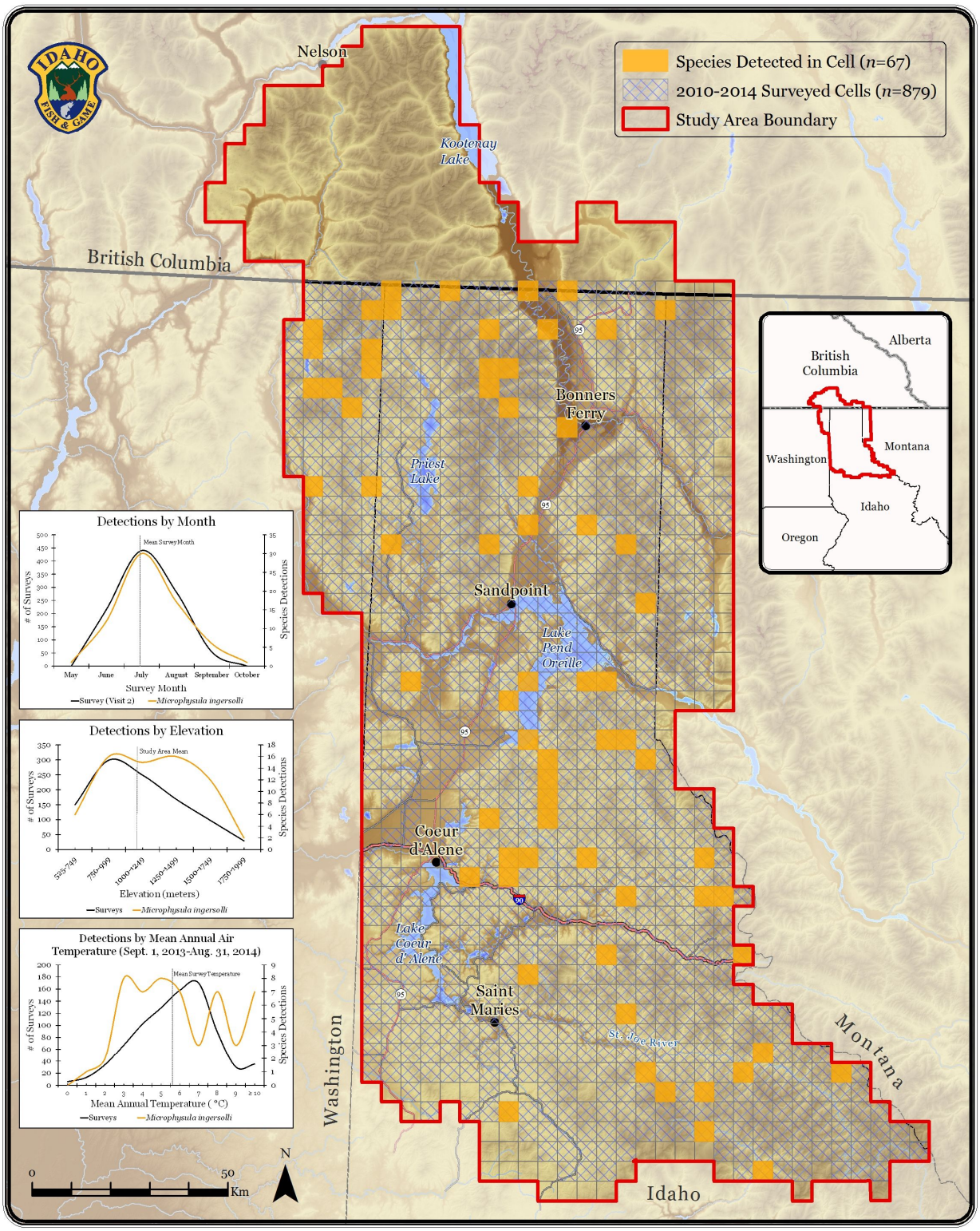
Map 2-35.

Multi-species Baseline Initiative: Magnum Mantleslug (*Magnipelta mycophaga*) Detections



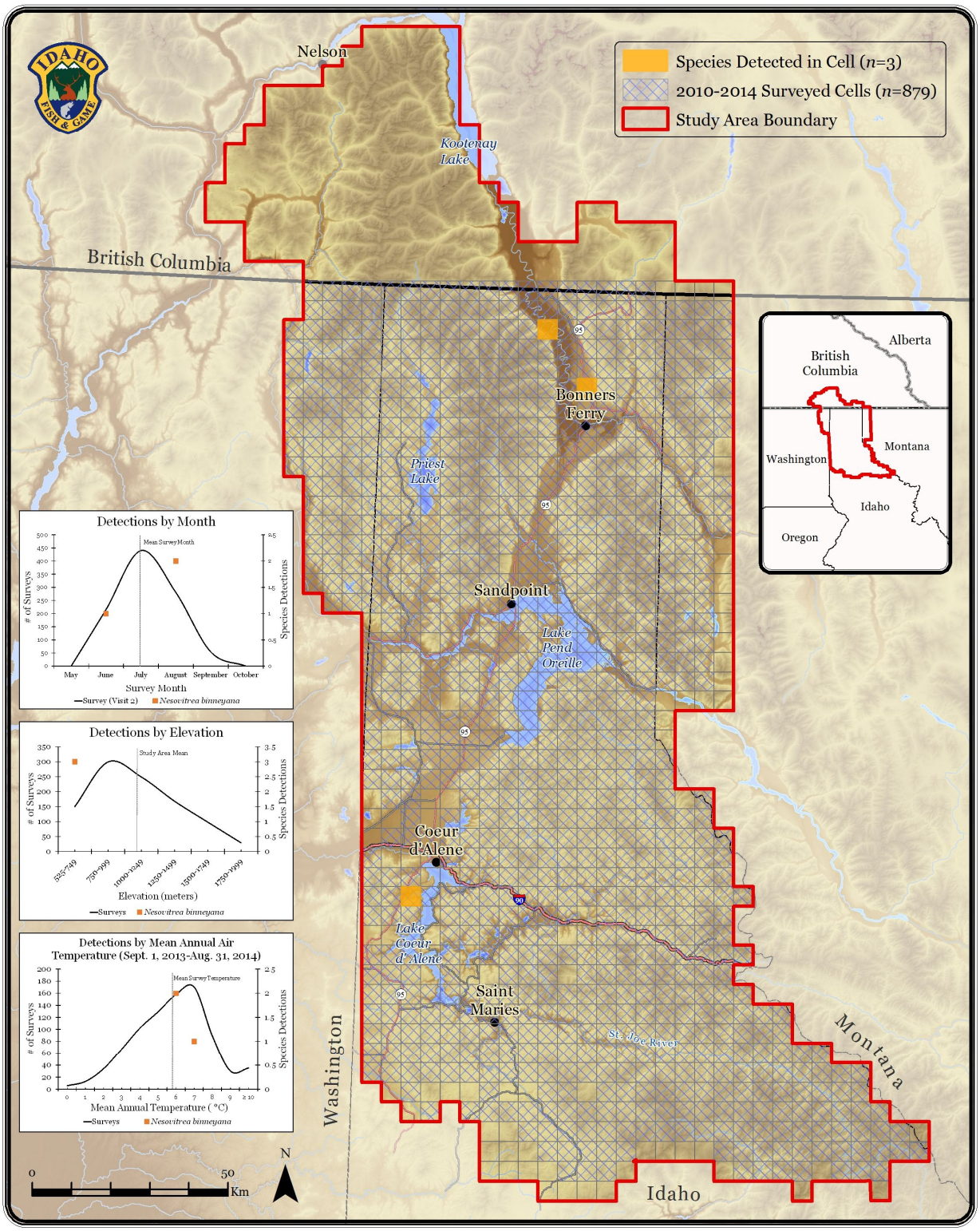
Map 2-36.

Multi-species Baseline Initiative: Spruce Snail (*Microphysula ingersolli*) Detections



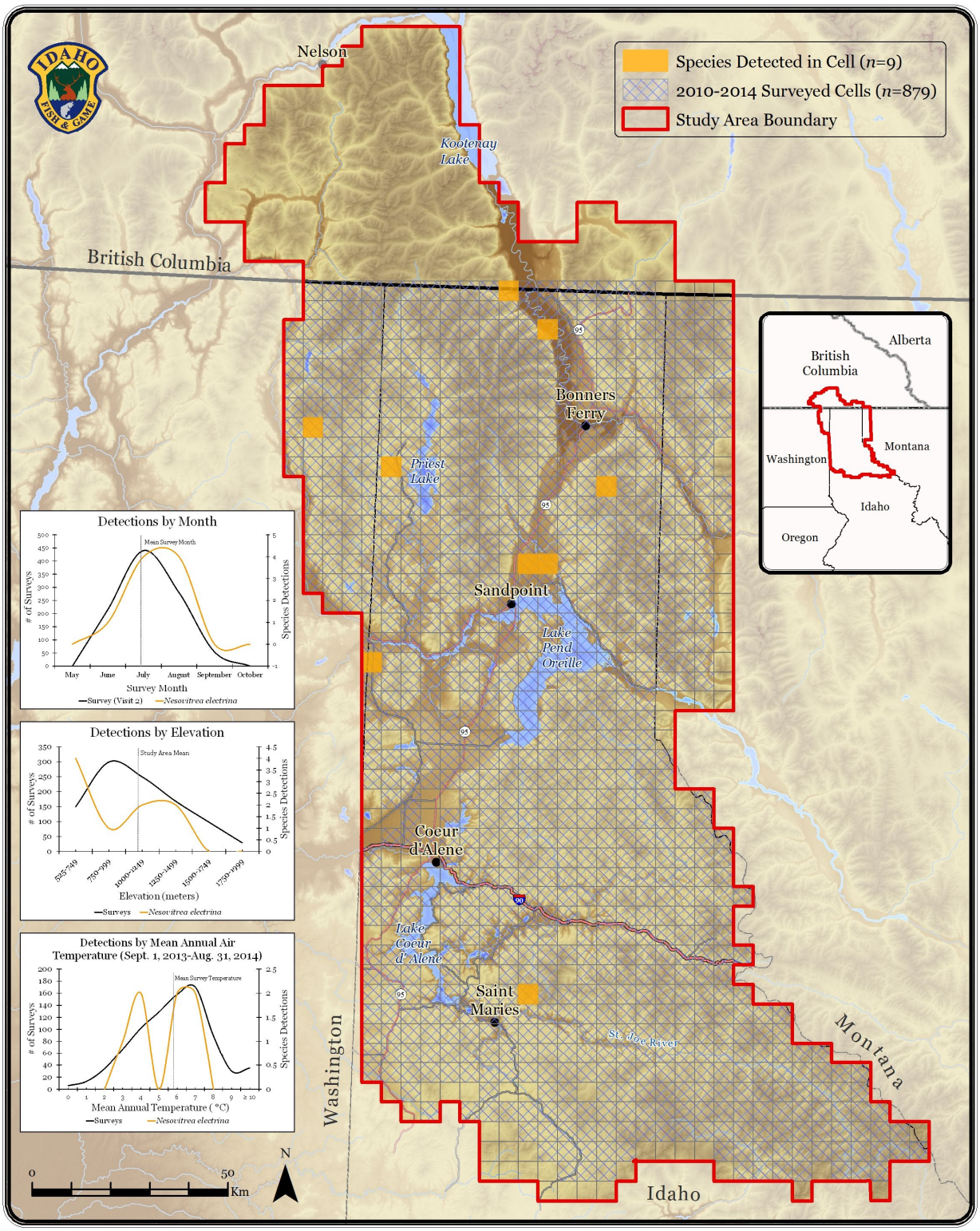
Map 2-37.

Multi-species Baseline Initiative: Blue Glass (*Nesovitrea binneyana*) Detections



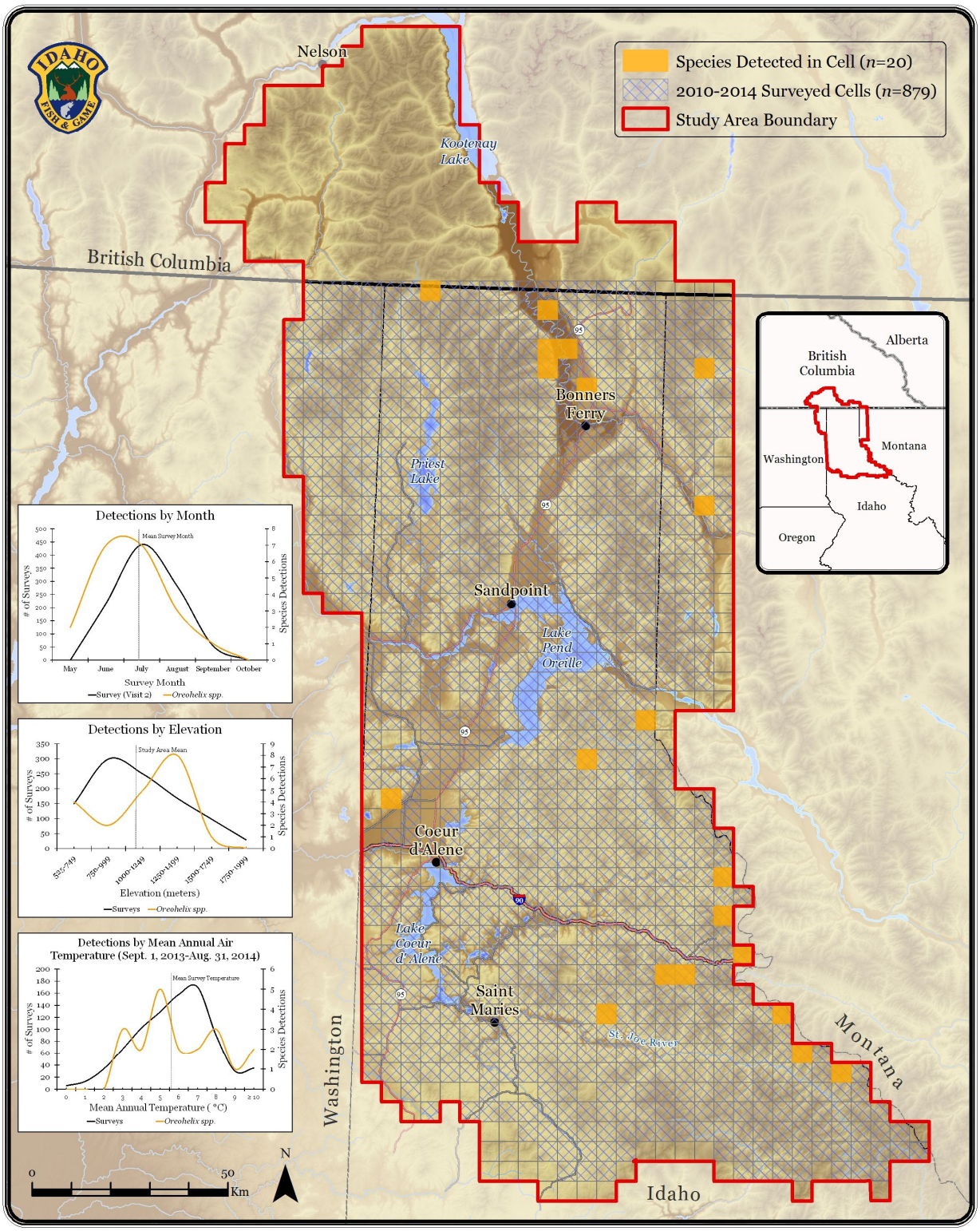
Map 2-38.

Multi-species Baseline Initiative: Amber Glass (*Nesovitrea electrina*) Detections



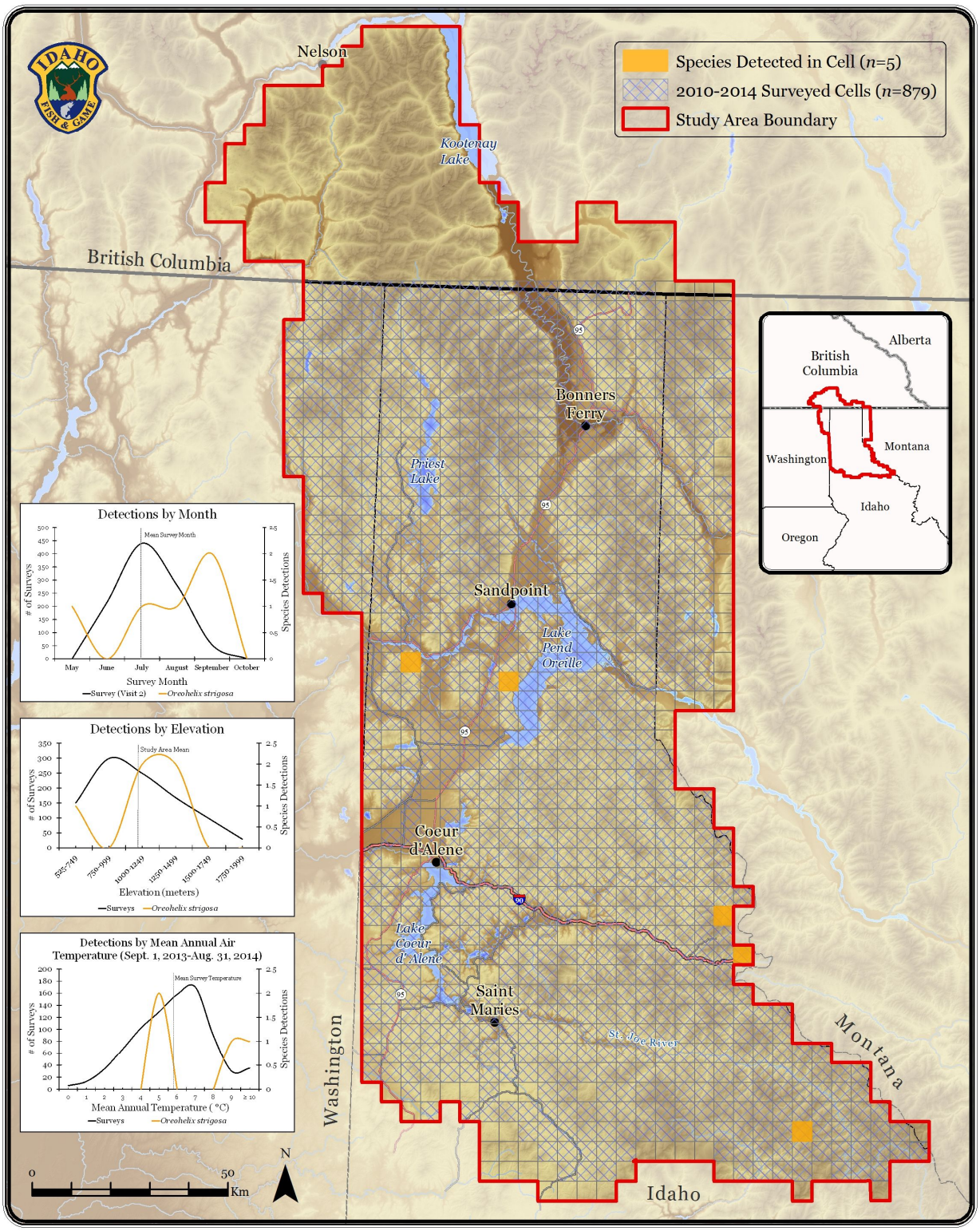
Map 2-39.

Multi-species Baseline Initiative: *Oreohelix* spp. Detections



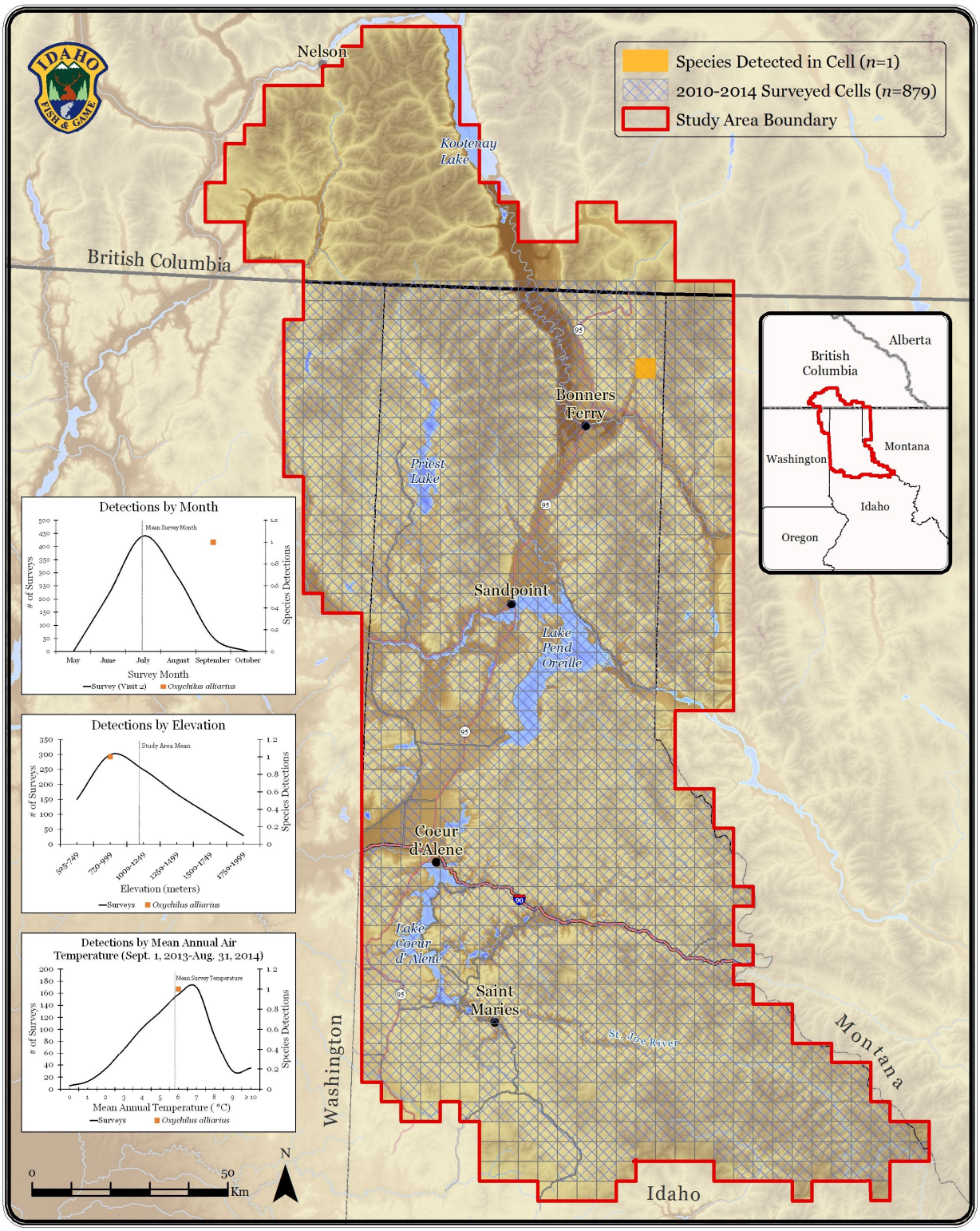
Map 2-40.

Multi-species Baseline Initiative: Rocky Mountainsnail (*Oreohelix strigosa*) Detections



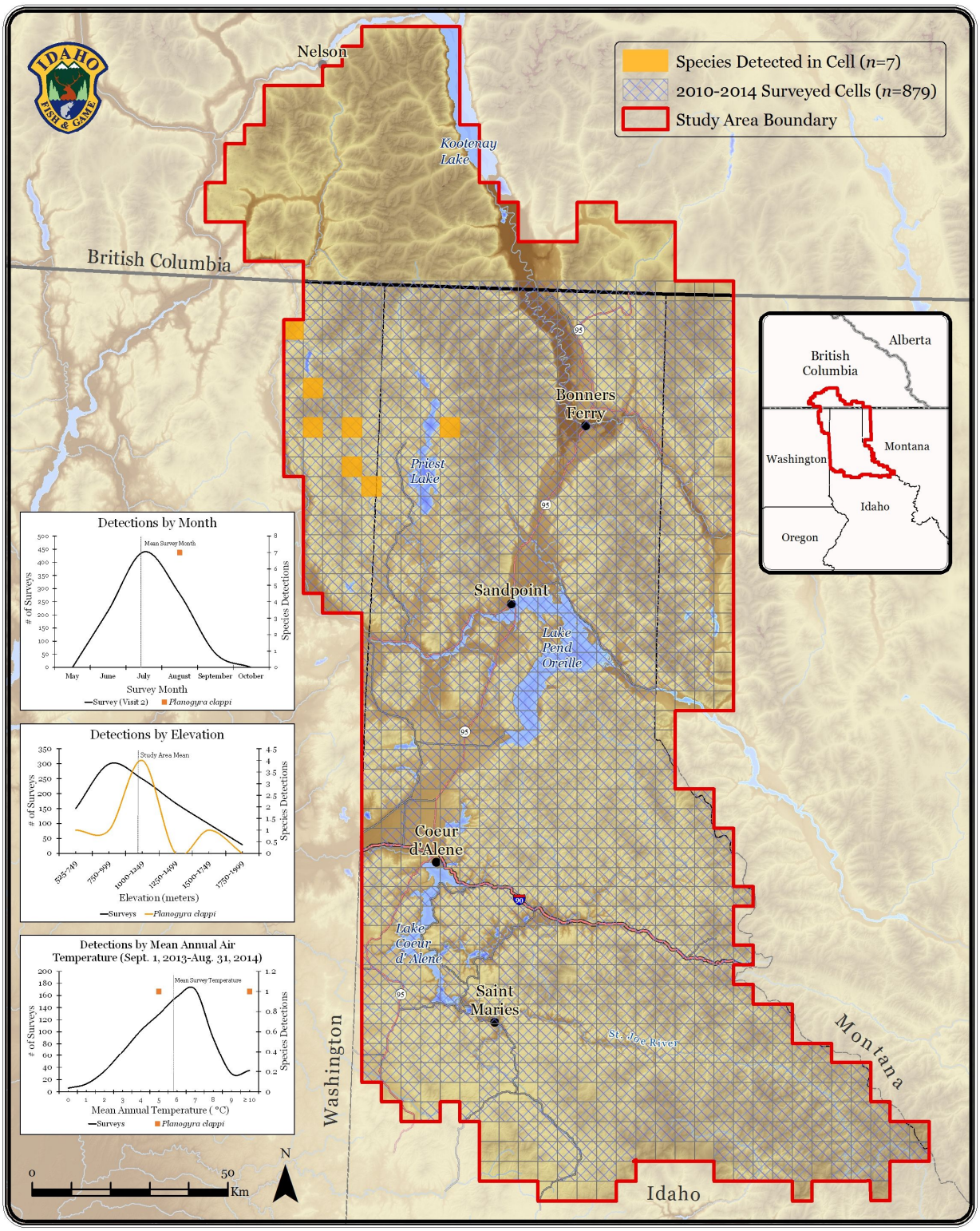
Map 2-41.

Multi-species Baseline Initiative: Garlic Glass-snail (*Oxychilus alliarius*) Detections



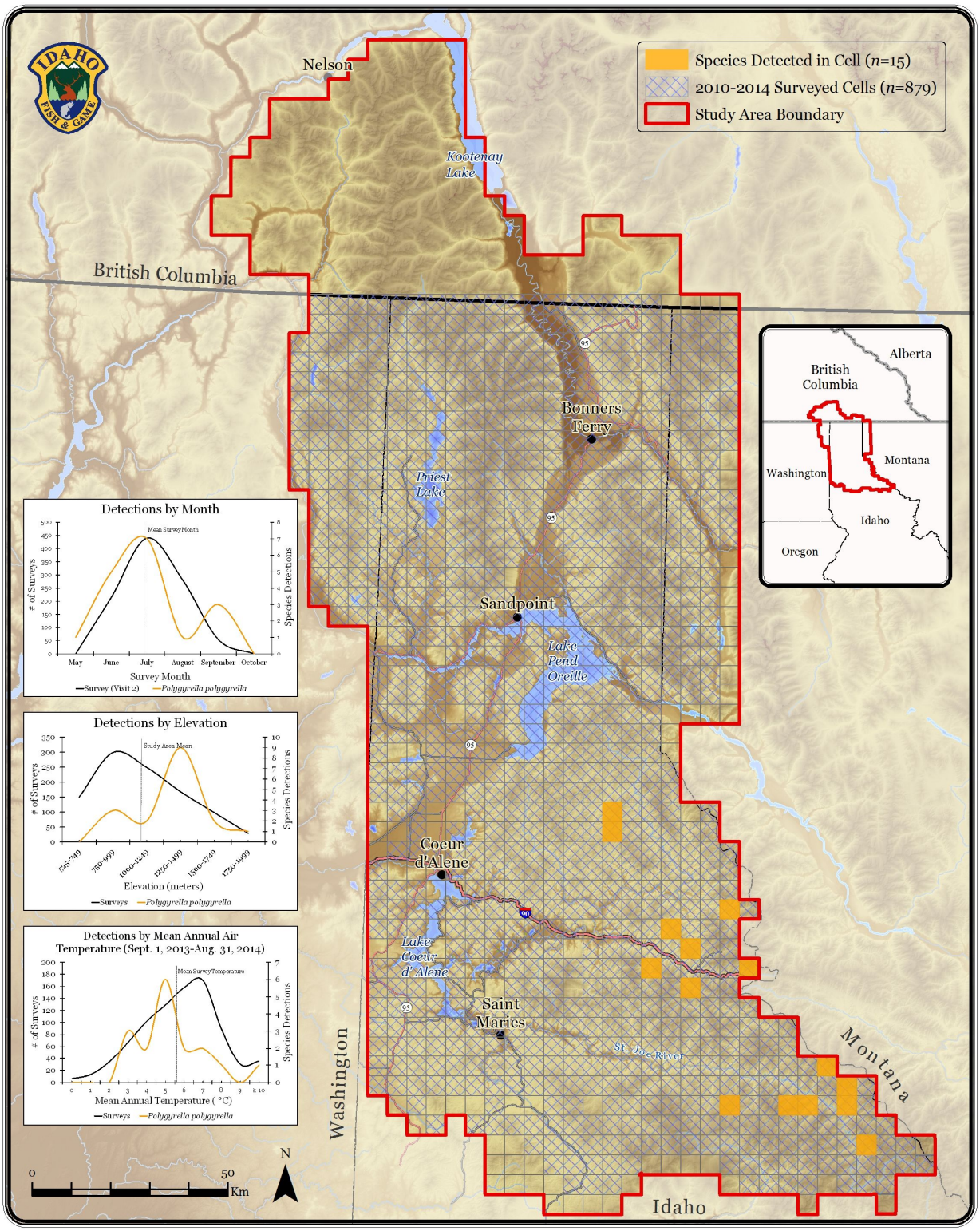
Map 2-42.

Multi-species Baseline Initiative: Western Flatwhorl (*Planogyra clappi*) Detections



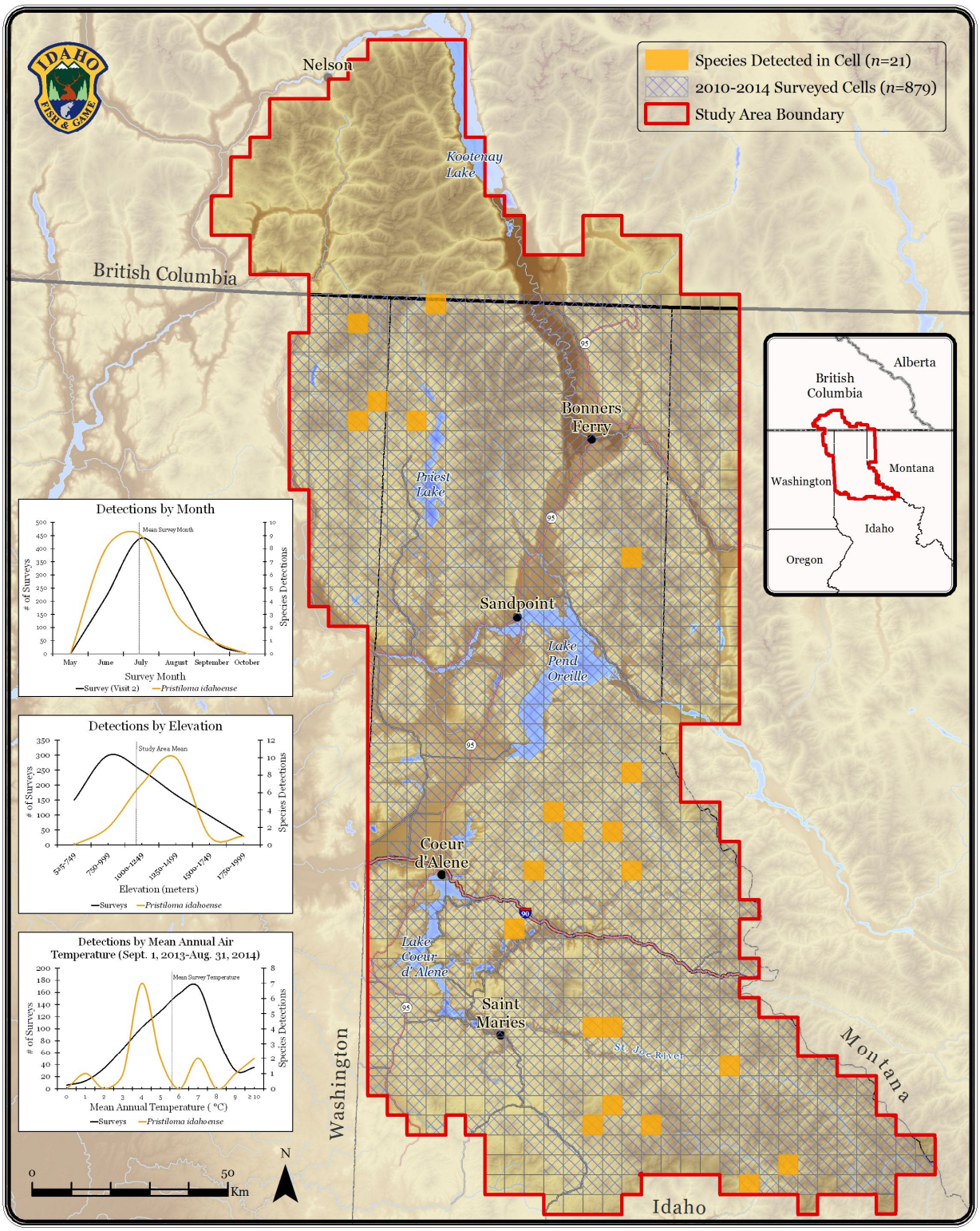
Map 2-43.

Multi-species Baseline Initiative: Humped Coin (*Polygyrella polygyrella*) Detections



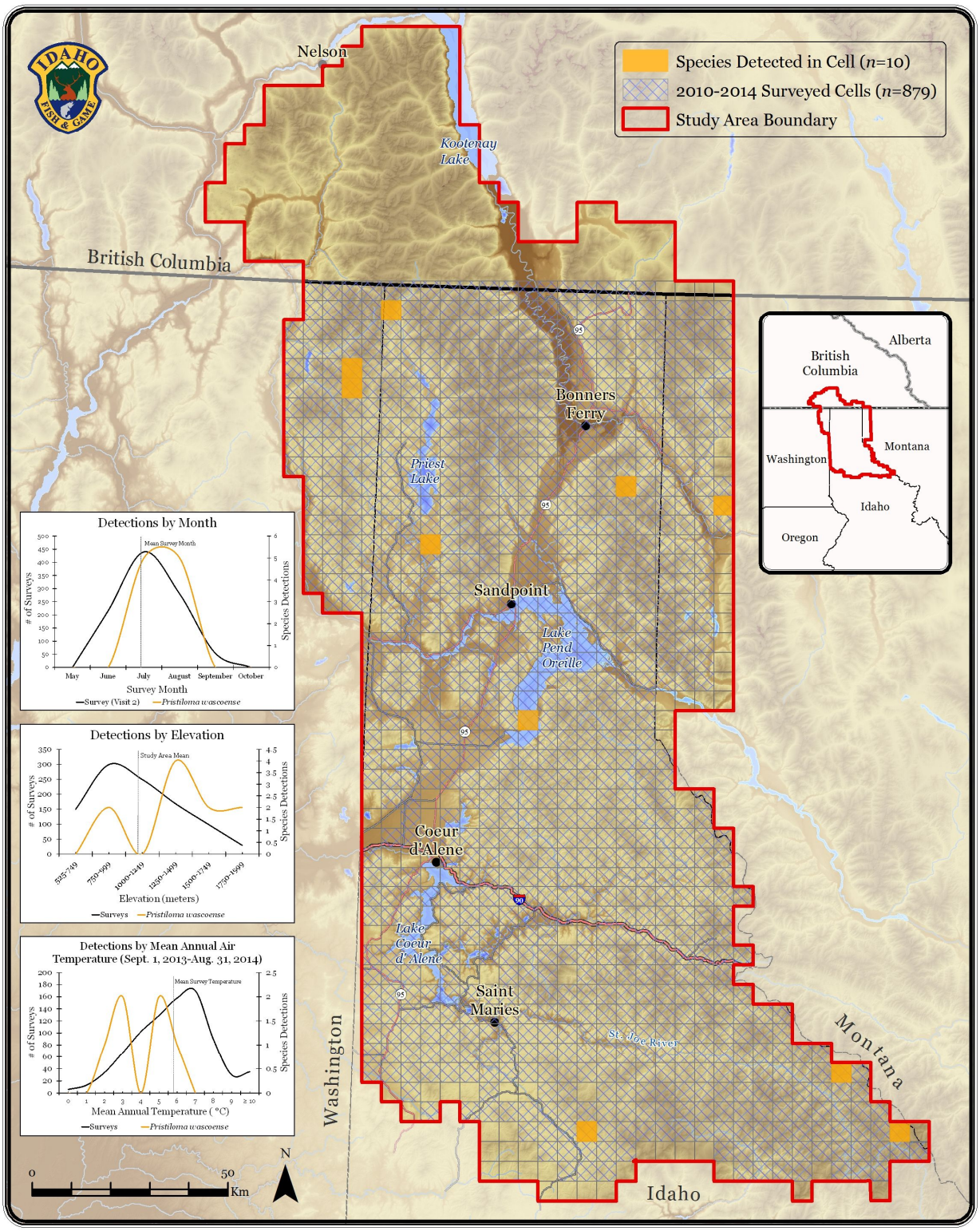
Map 2-44.

Multi-species Baseline Initiative: Thinlip Tightcoil (*Pristiloma idahoense*) Detections



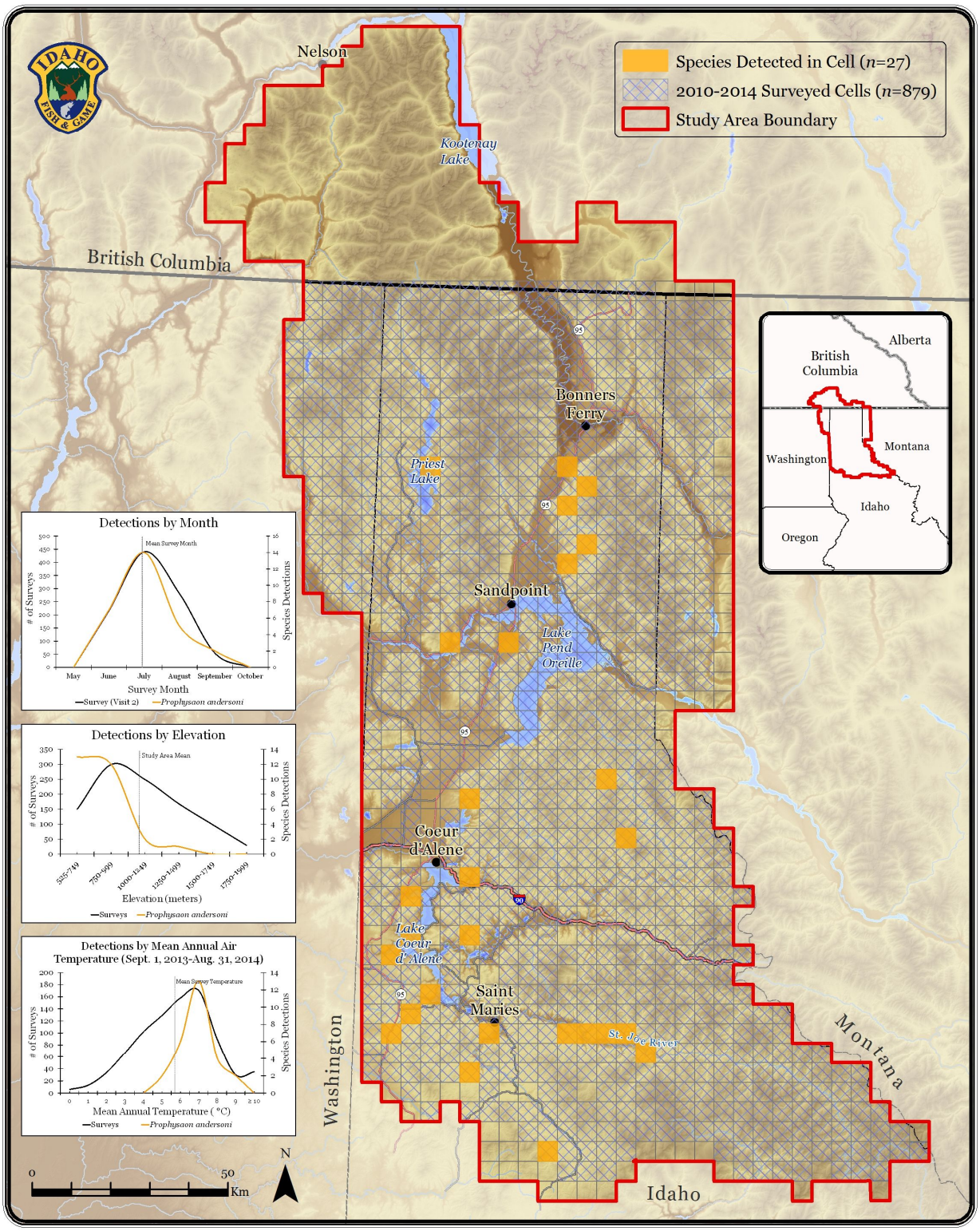
Map 2-45.

Multi-species Baseline Initiative: Shiny Tightcoil (*Pristiloma wascoense*) Detections



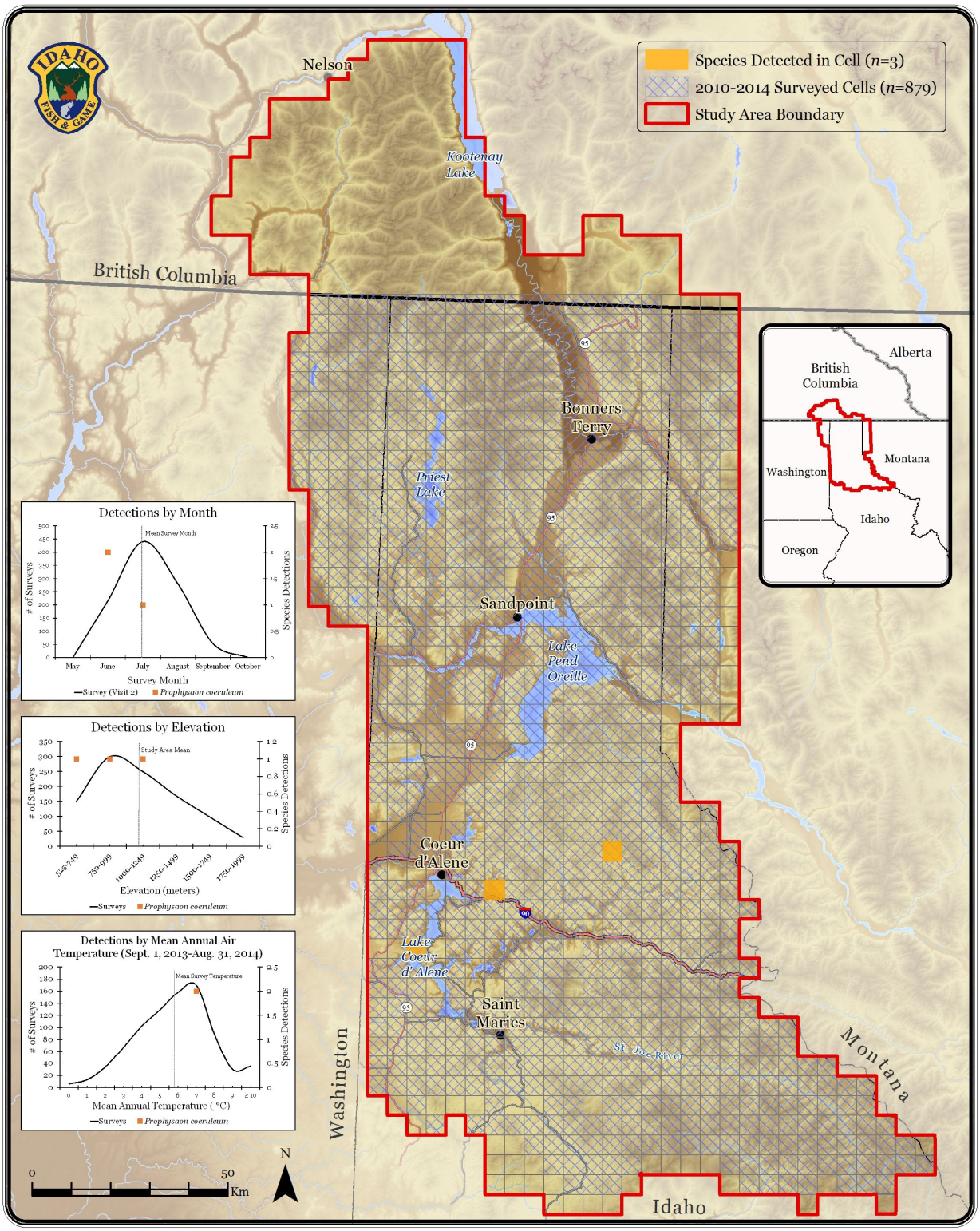
Map 2-46.

Multi-species Baseline Initiative: Reticulate Taildropper (*Prophysaon andersoni*) Detections



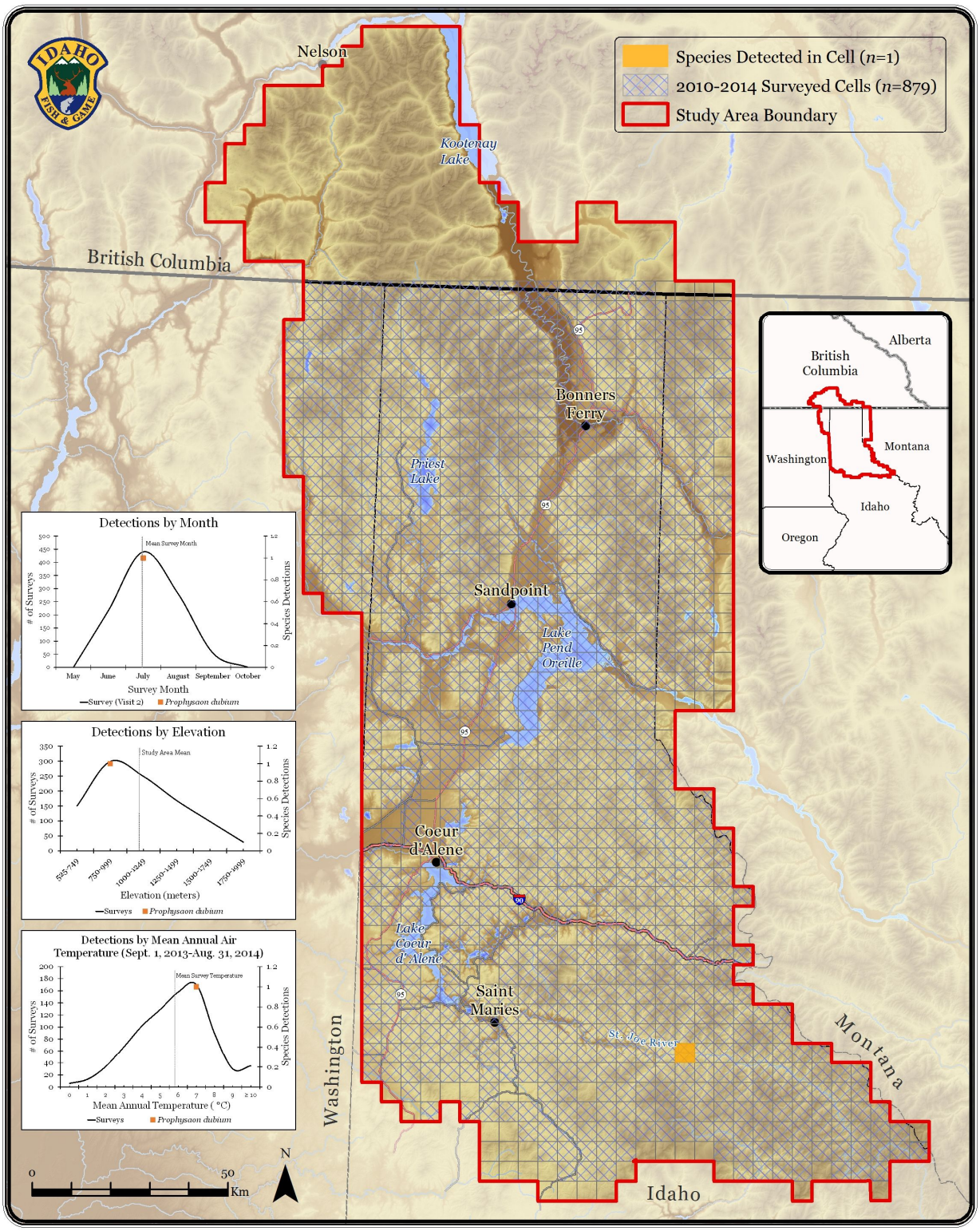
Map 2-47.

Multi-species Baseline Initiative: Blue-gray Taildropper (*Prophysaon coeruleum*) Detections



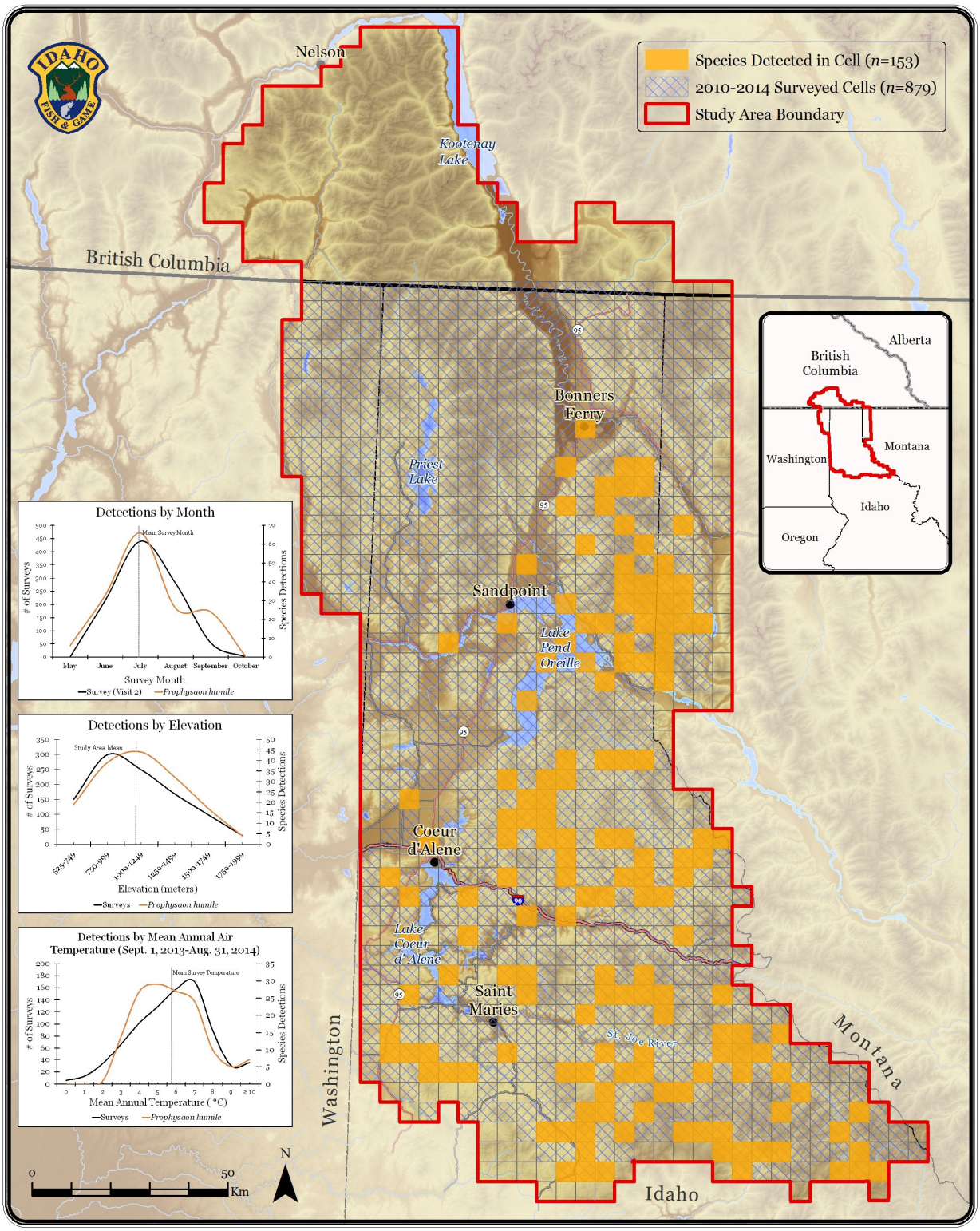
Map 2-48.

Multi-species Baseline Initiative: PapilloseTaildropper (*Prophysaon dubium*) Detections



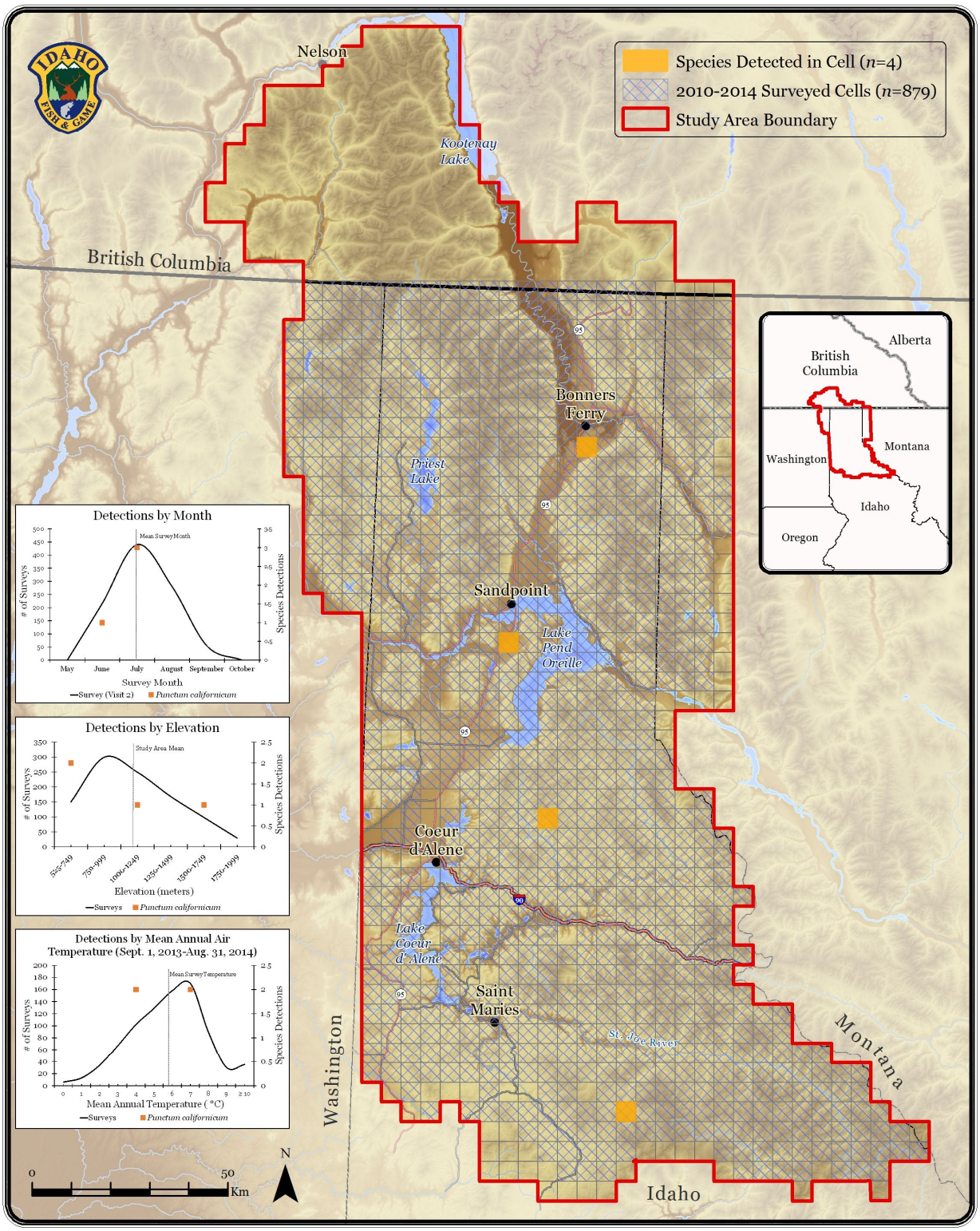
Map 2-49.

Multi-species Baseline Initiative: Smoky Taildropper (*Prophysaon humile*) Detections



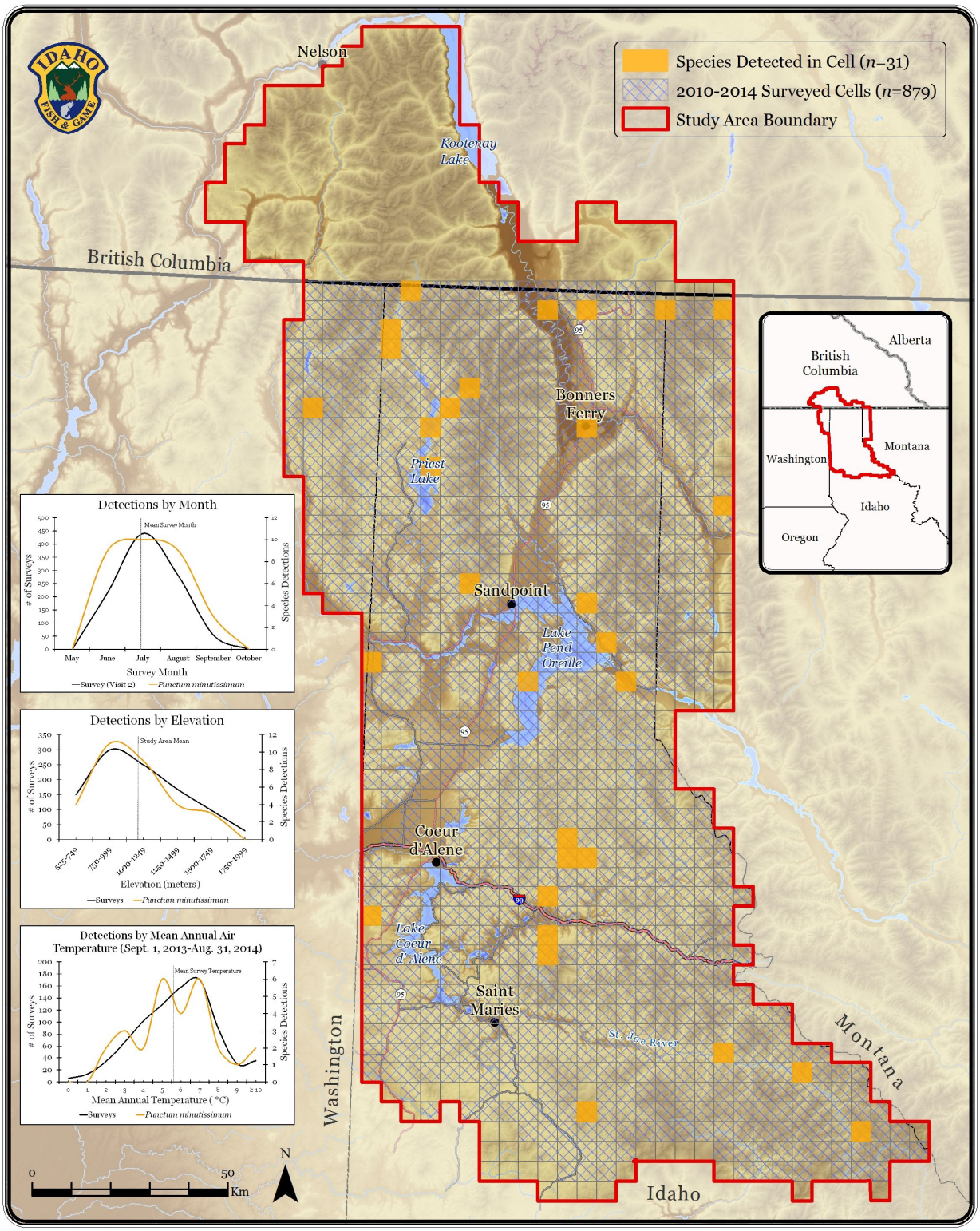
Map 2-50.

Multi-species Baseline Initiative: Ribbed Spot (*Punctum californicum*) Detections



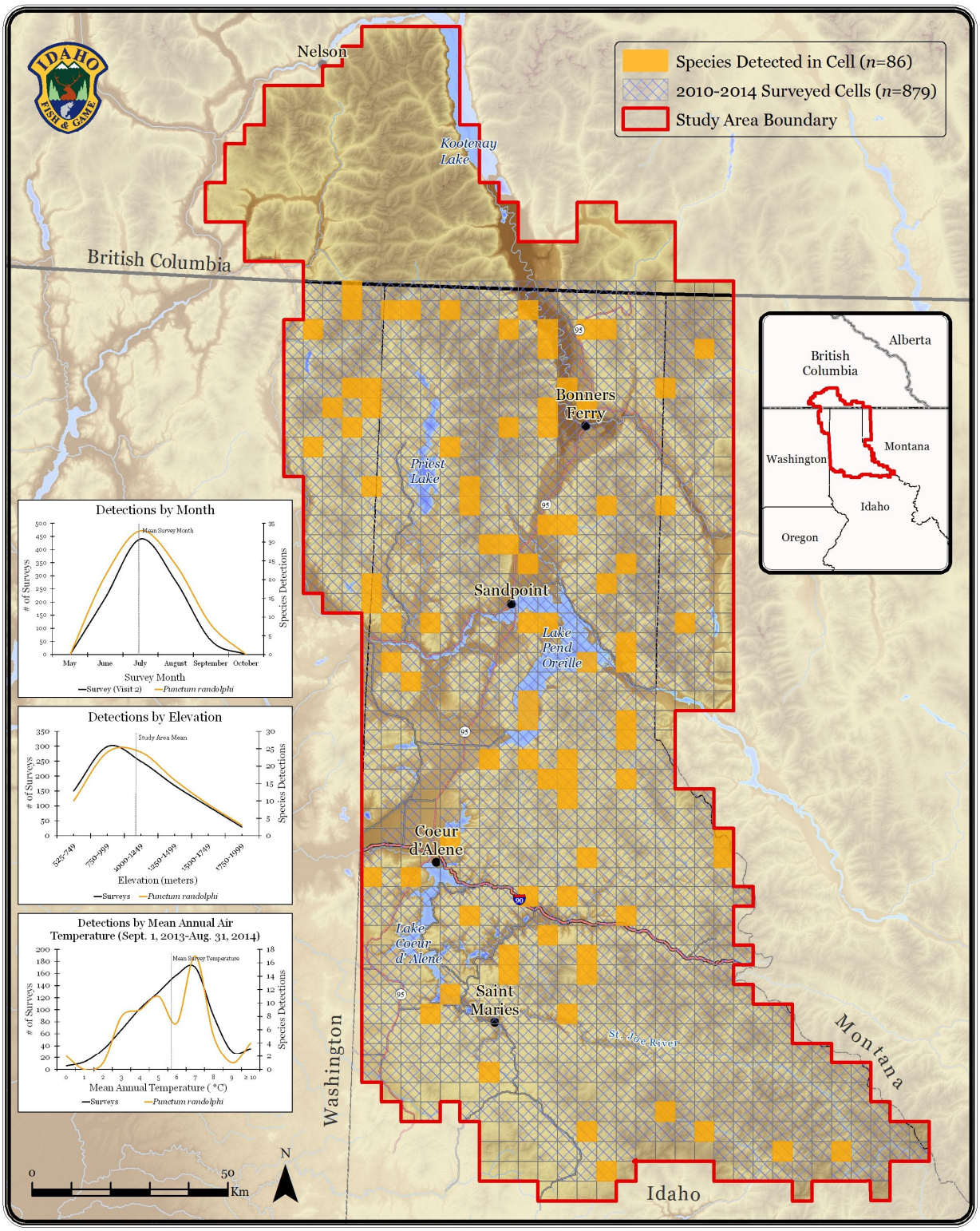
Map 2-51.

Multi-species Baseline Initiative: Small Spot (*Punctum minutissimum*) Detections



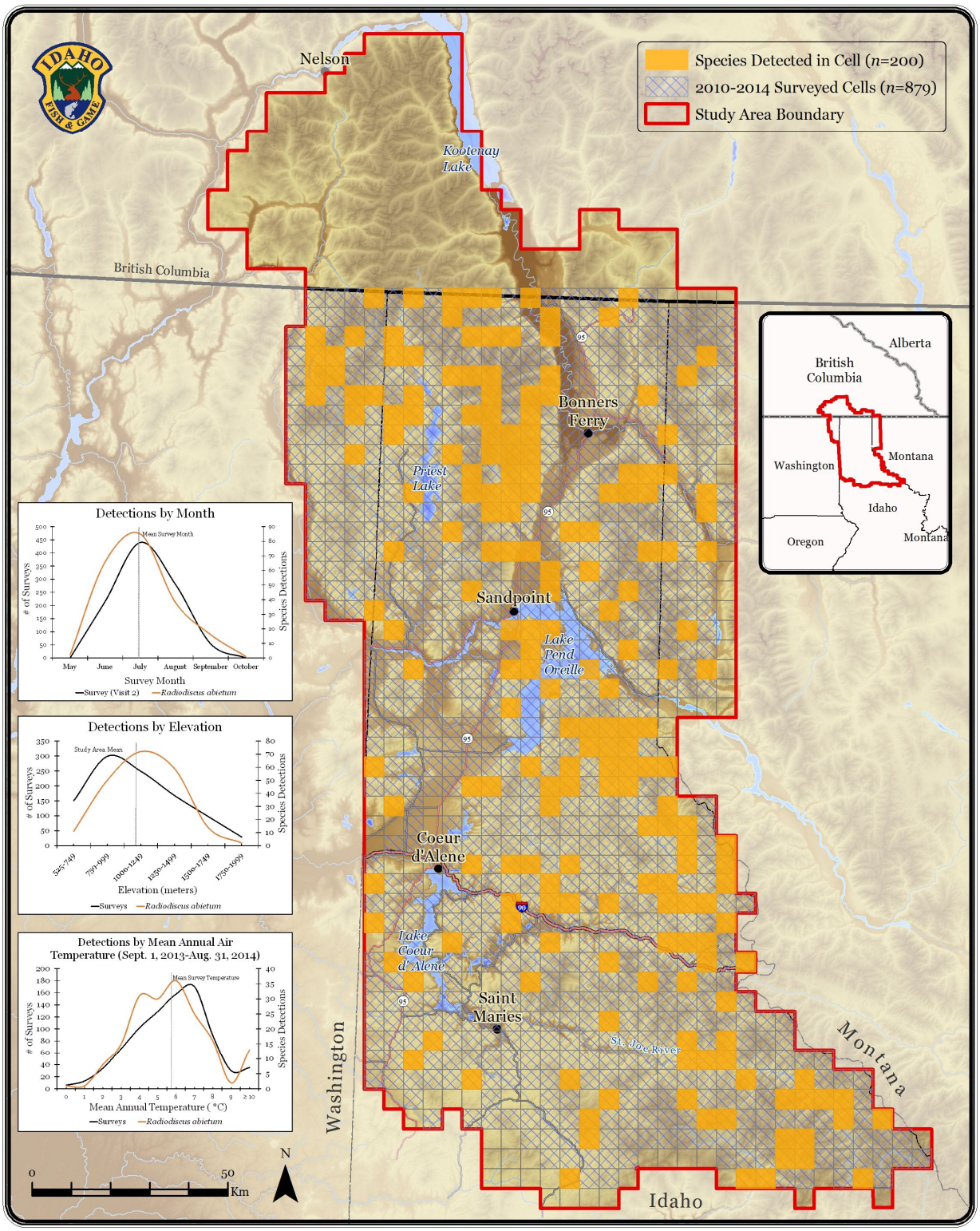
Map 2-52.

Multi-species Baseline Initiative: Conical Spot (*Punctum randolphi*) Detections



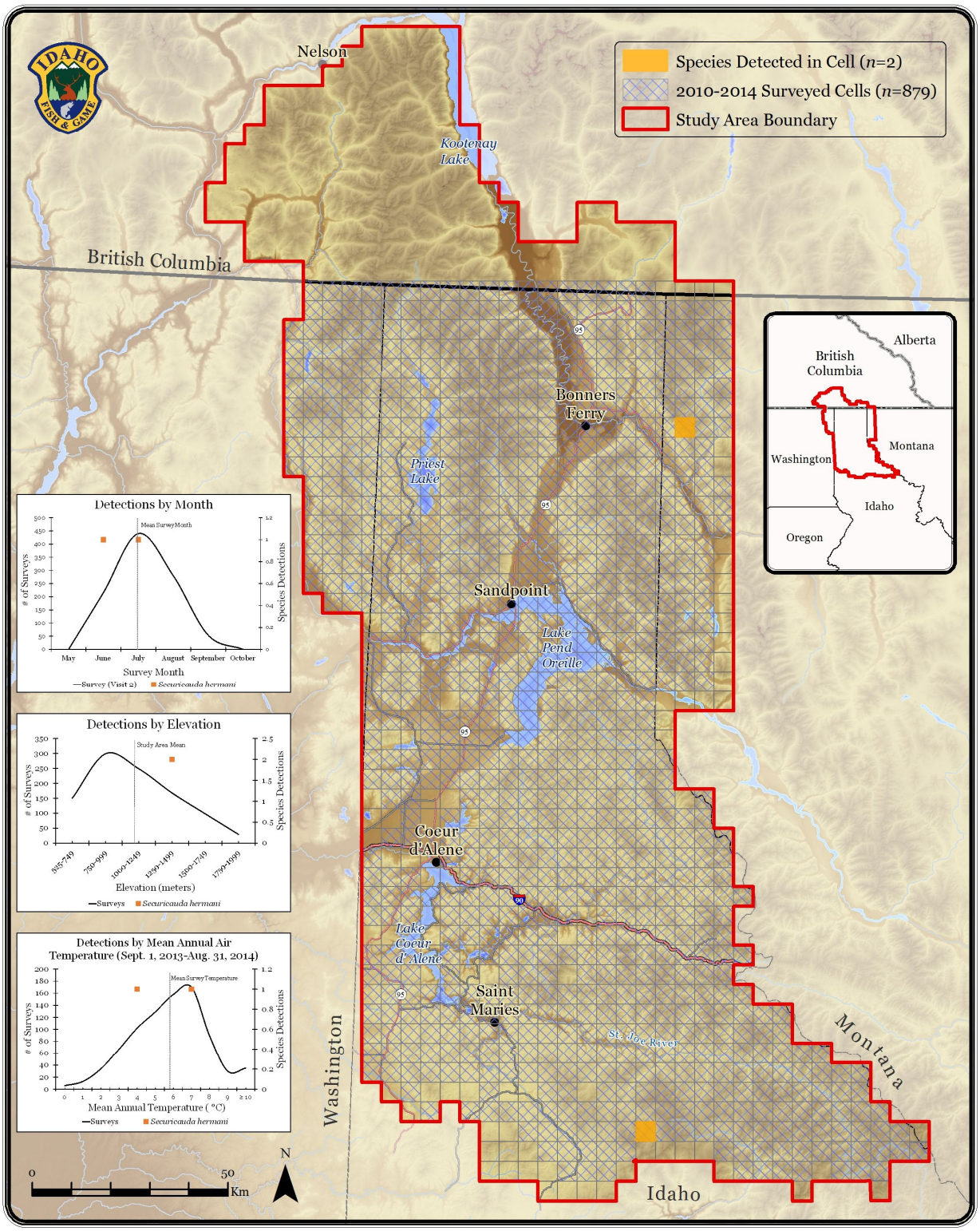
Map 2-53.

Multi-species Baseline Initiative: Fir Pinwheel (*Radiodiscus abietum*) Detections



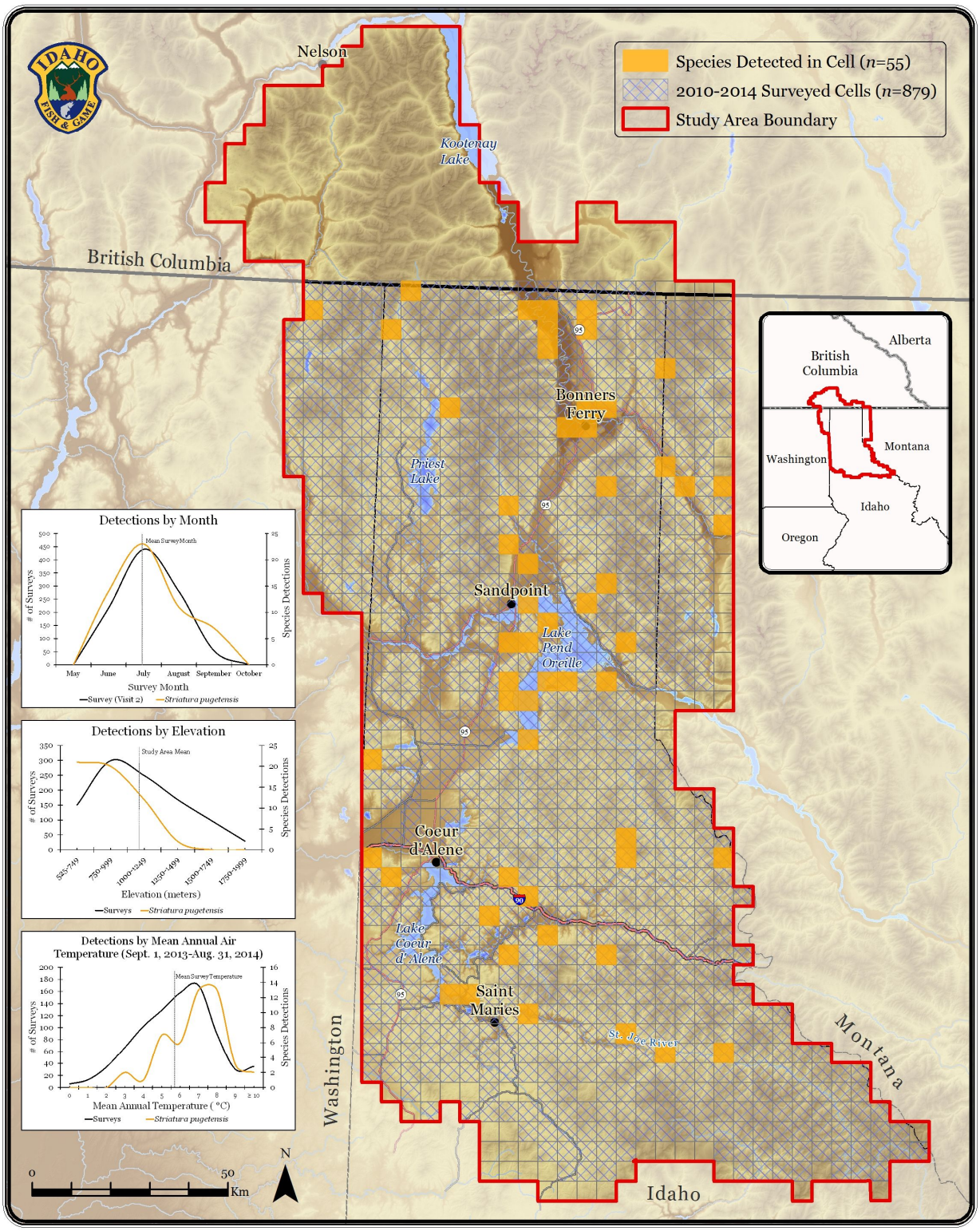
Map 2-54.

Multi-species Baseline Initiative: Rocky Mountain Axetail (*Securicauda hermani*) Detections



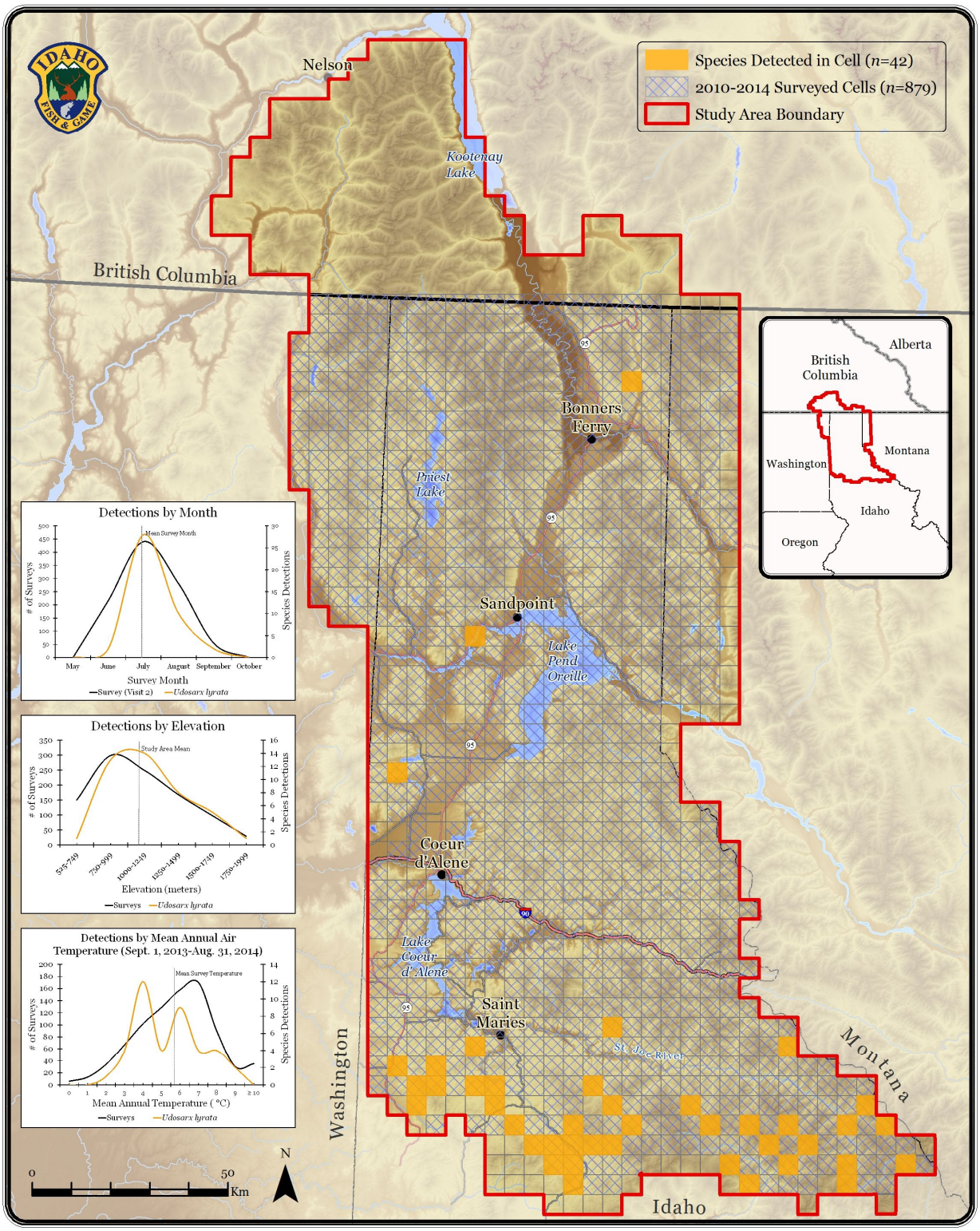
Map 2-55.

Multi-species Baseline Initiative: Northwest Striate (*Striatura pugetensis*) Detections



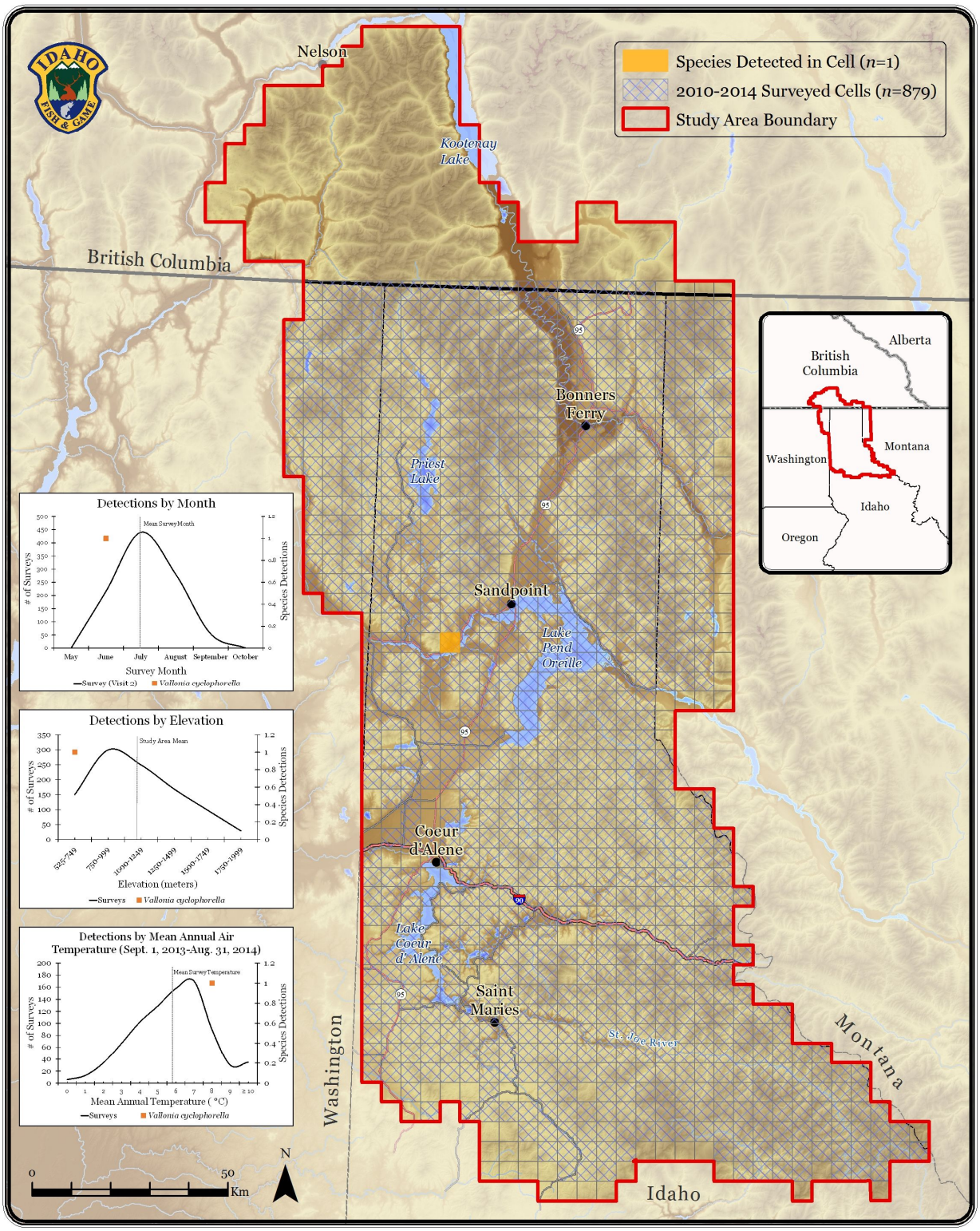
Map 2-56.

Multi-species Baseline Initiative: Lyre Mantleslug (*Udosarx lyrata*) Detections



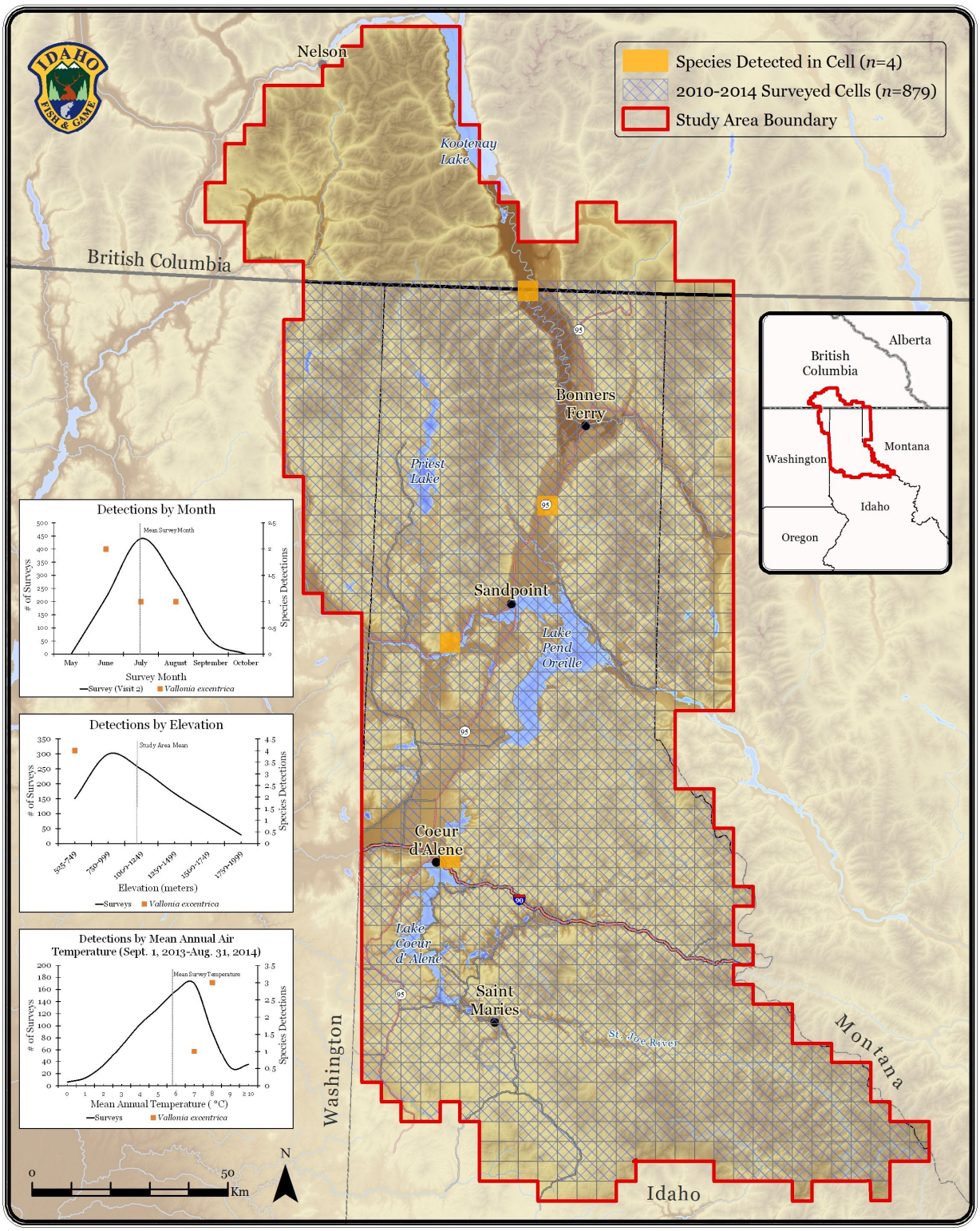
Map 2-57.

Multi-species Baseline Initiative: Silky Vallonia (*Vallonia cyclophorella*) Detections



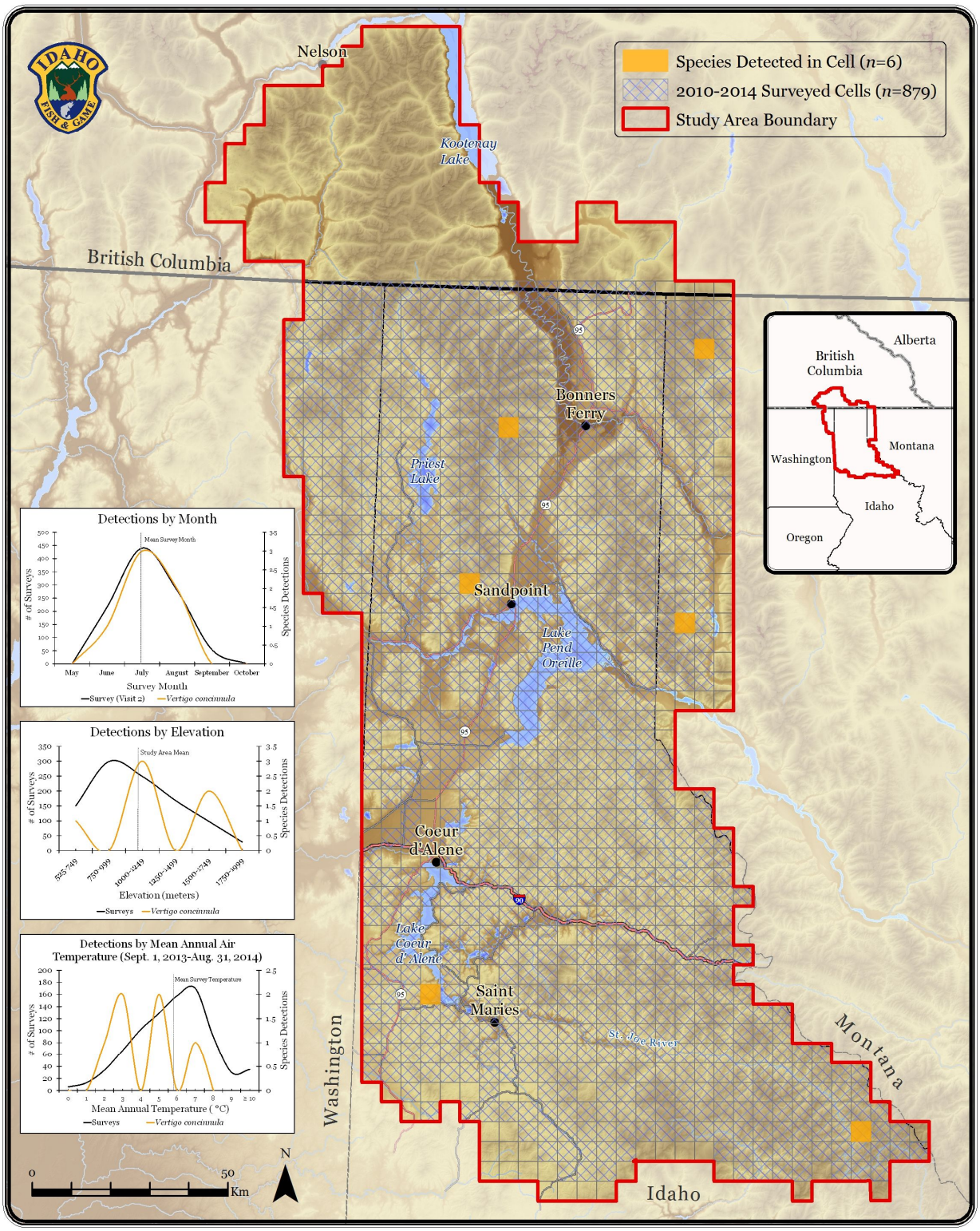
Map 2-58.

Multi-species Baseline Initiative: Iroquois Vallonia (*Vallonia excentrica*) Detections



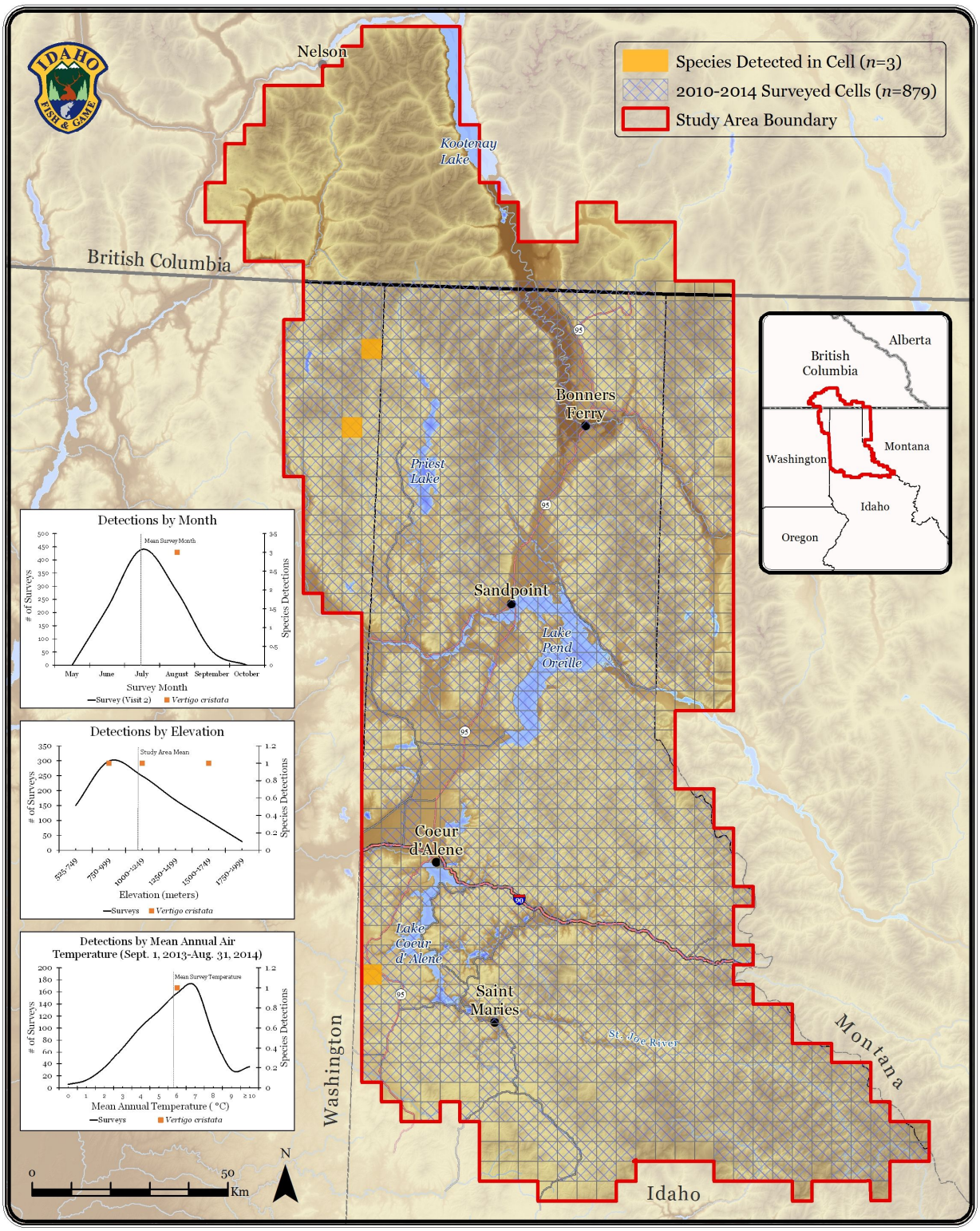
Map 2-59.

Multi-species Baseline Initiative: Mitered Vertigo (*Vertigo concinnula*) Detections



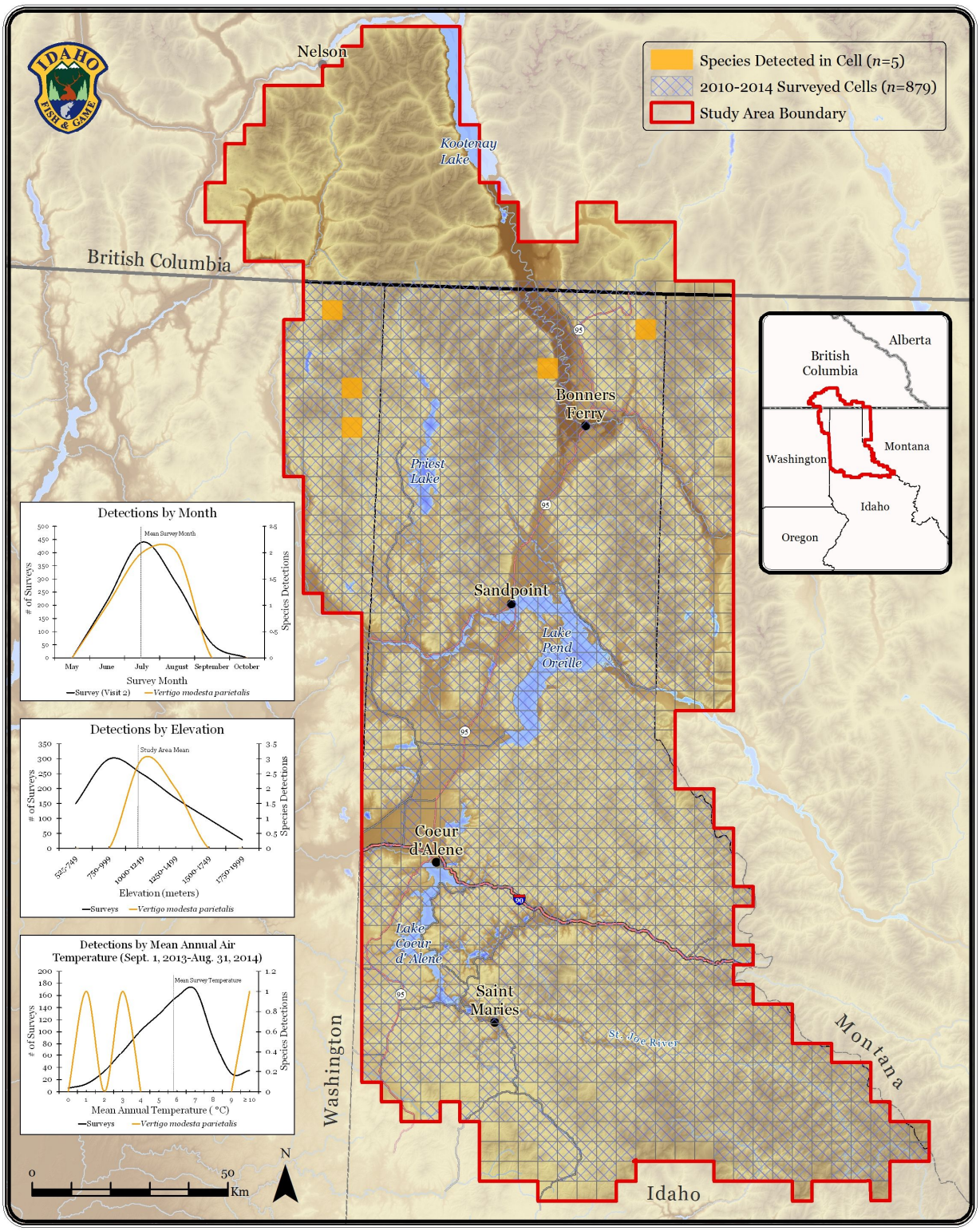
Map 2-60.

Multi-species Baseline Initiative: Crested Vertigo (*Vertigo cristata*) Detections



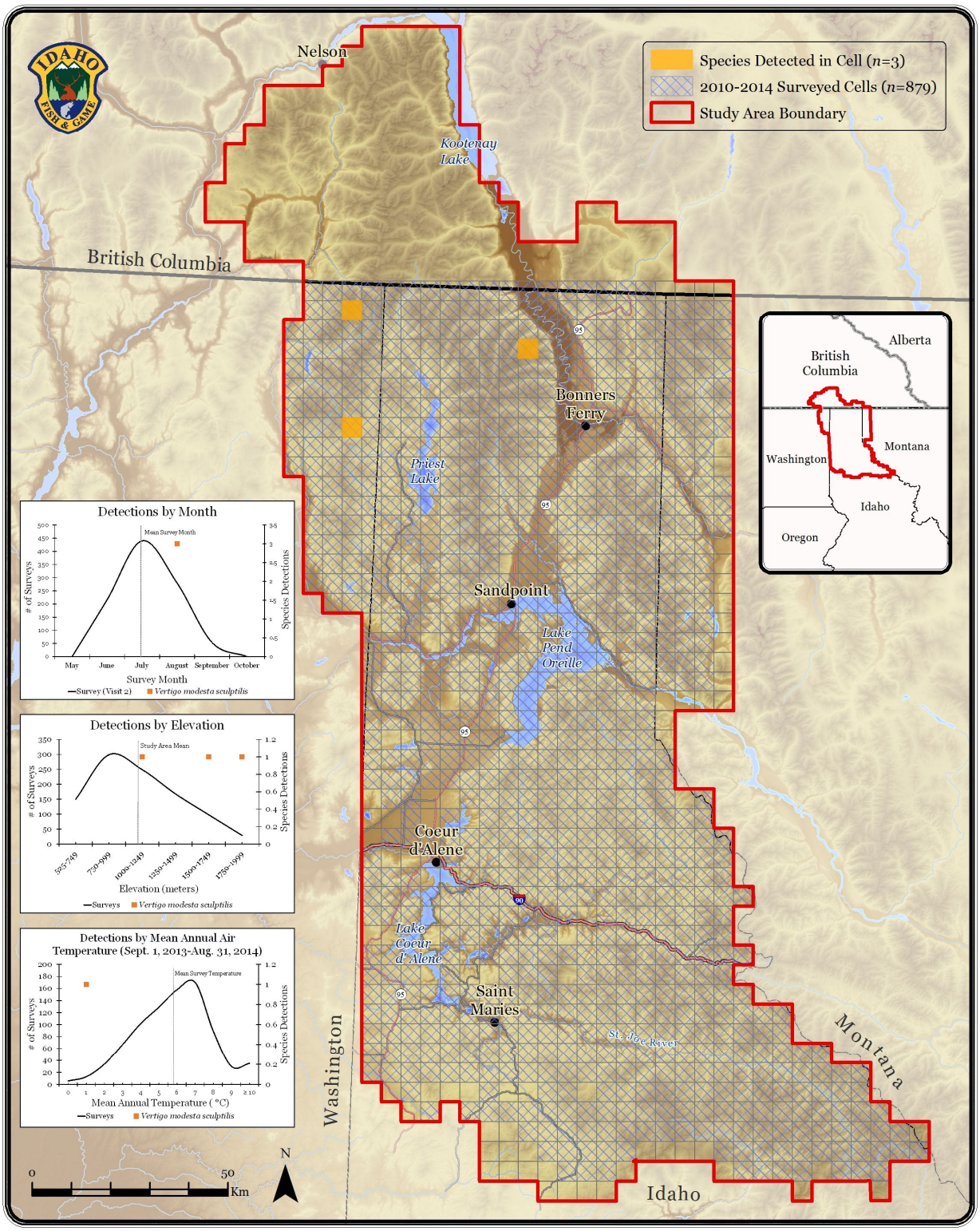
Map 2-61.

Multi-species Baseline Initiative: *Vertigo modesta parietalis* Detections



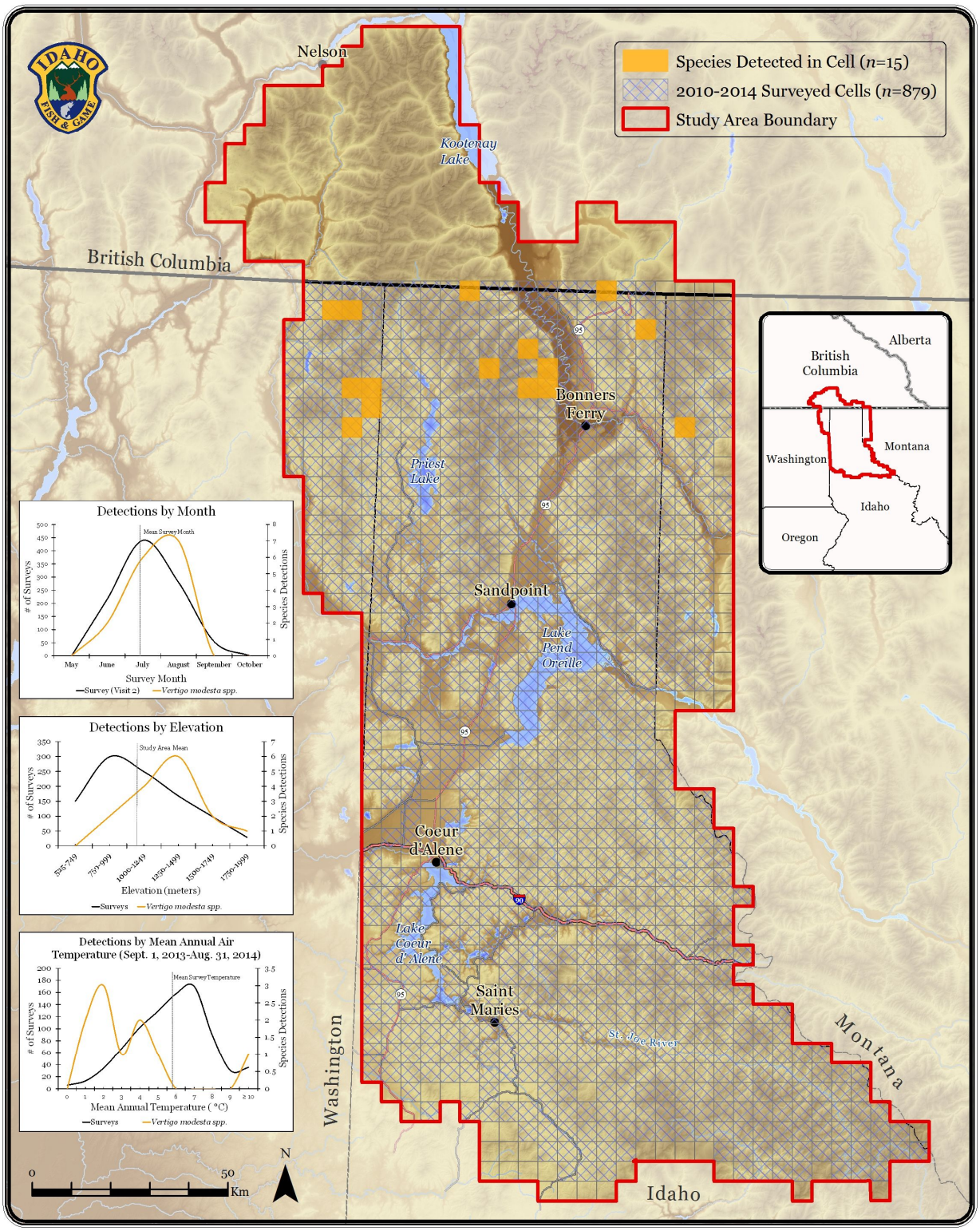
Map 2-62.

Multi-species Baseline Initiative: *Vertigo modesta sculptilis* Detections



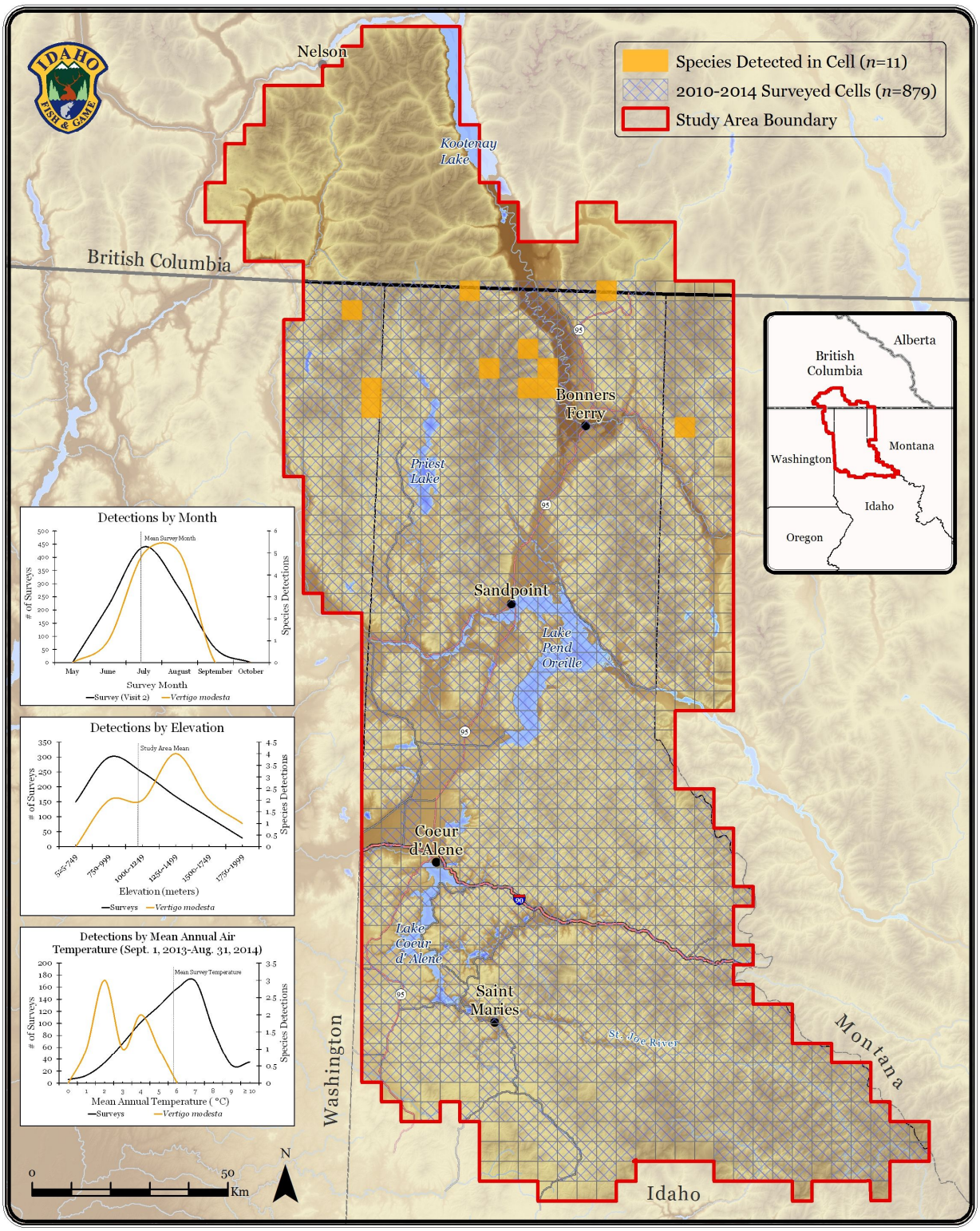
Map 2-63.

Multi-species Baseline Initiative: *Vertigo modesta* complex Detections



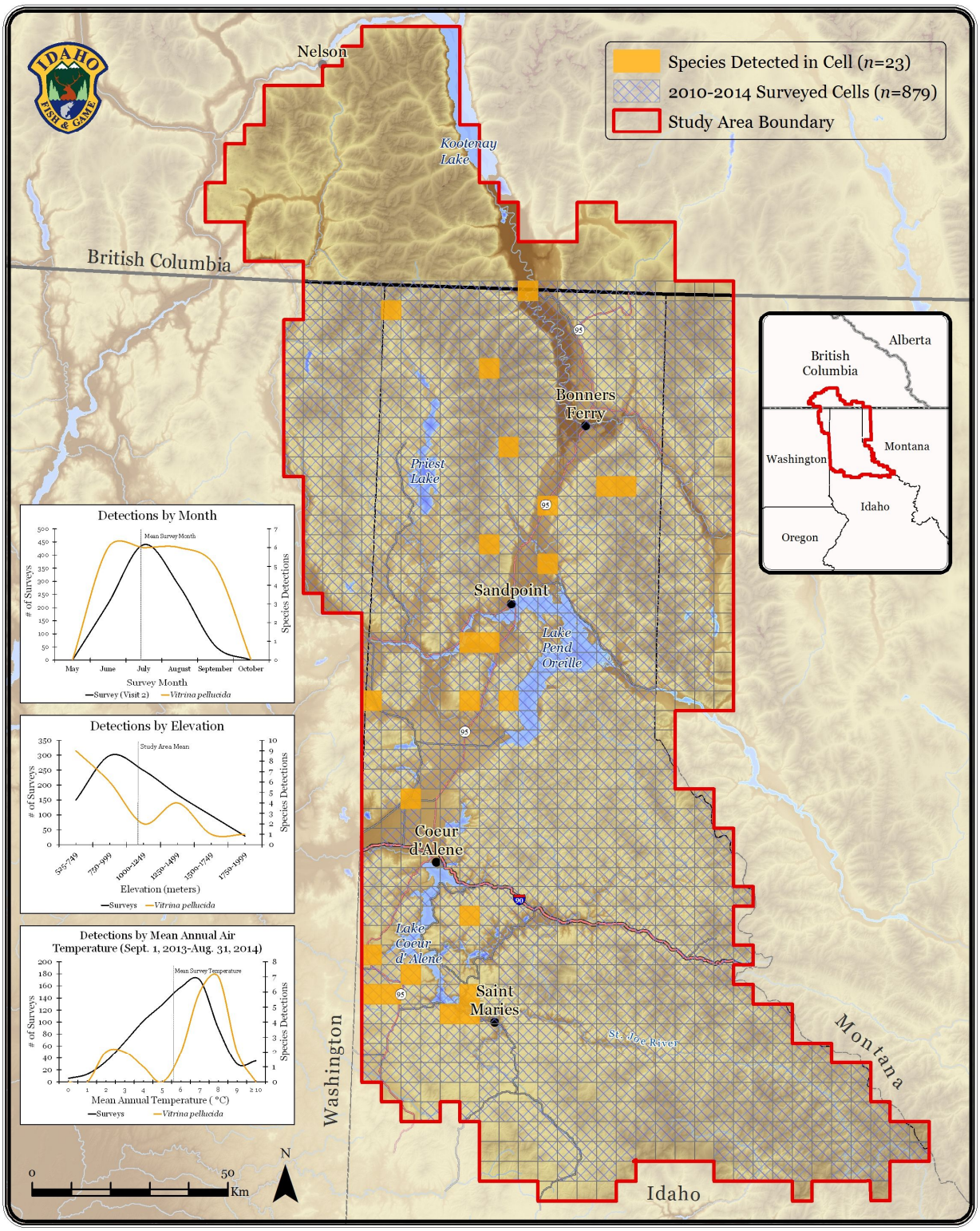
Map 2-64.

Multi-species Baseline Initiative: Cross Vertigo (*Vertigo modesta*) Detections



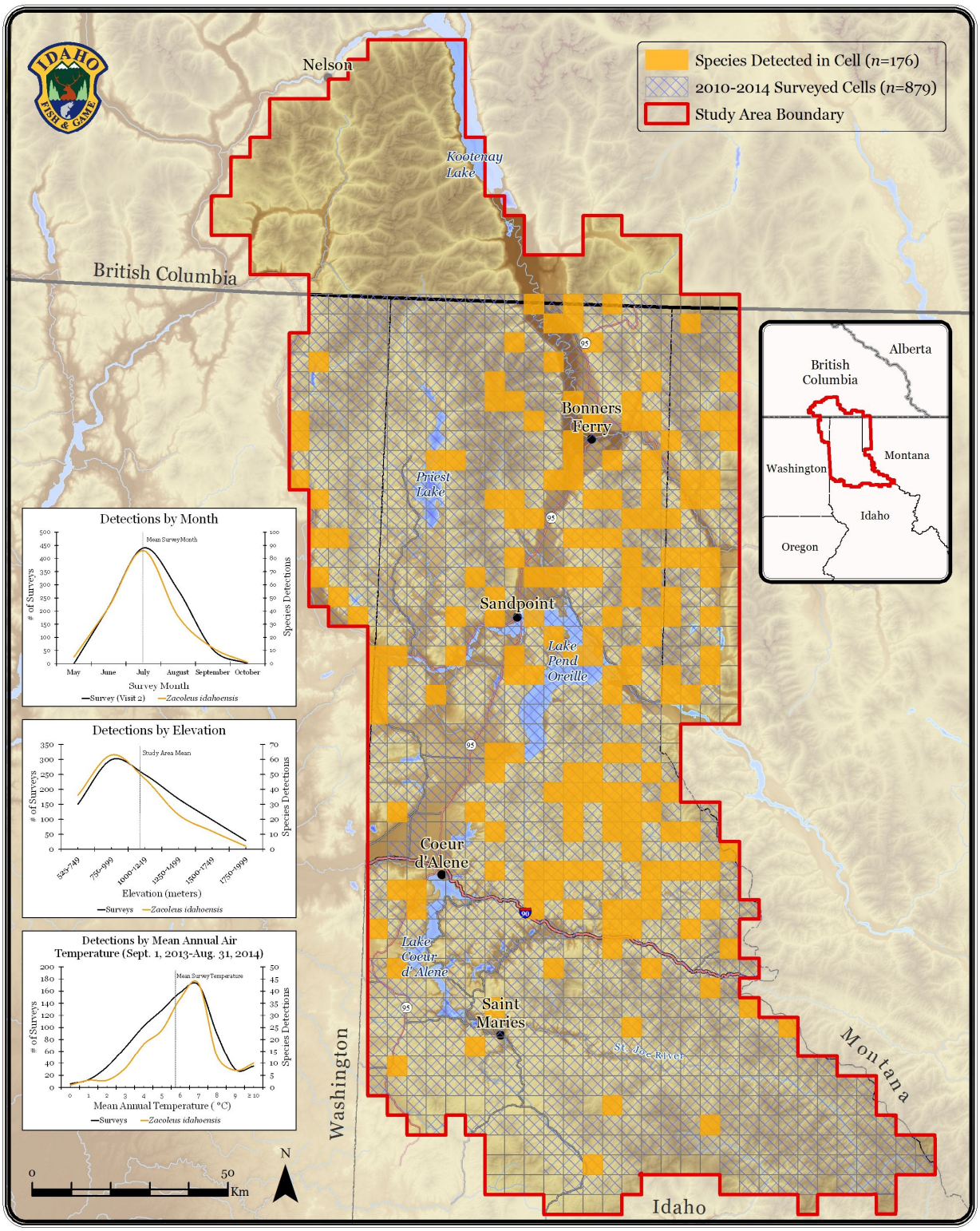
Map 2-65.

Multi-species Baseline Initiative: Western Glass-snail (*Vitrina pellucida*) Detections



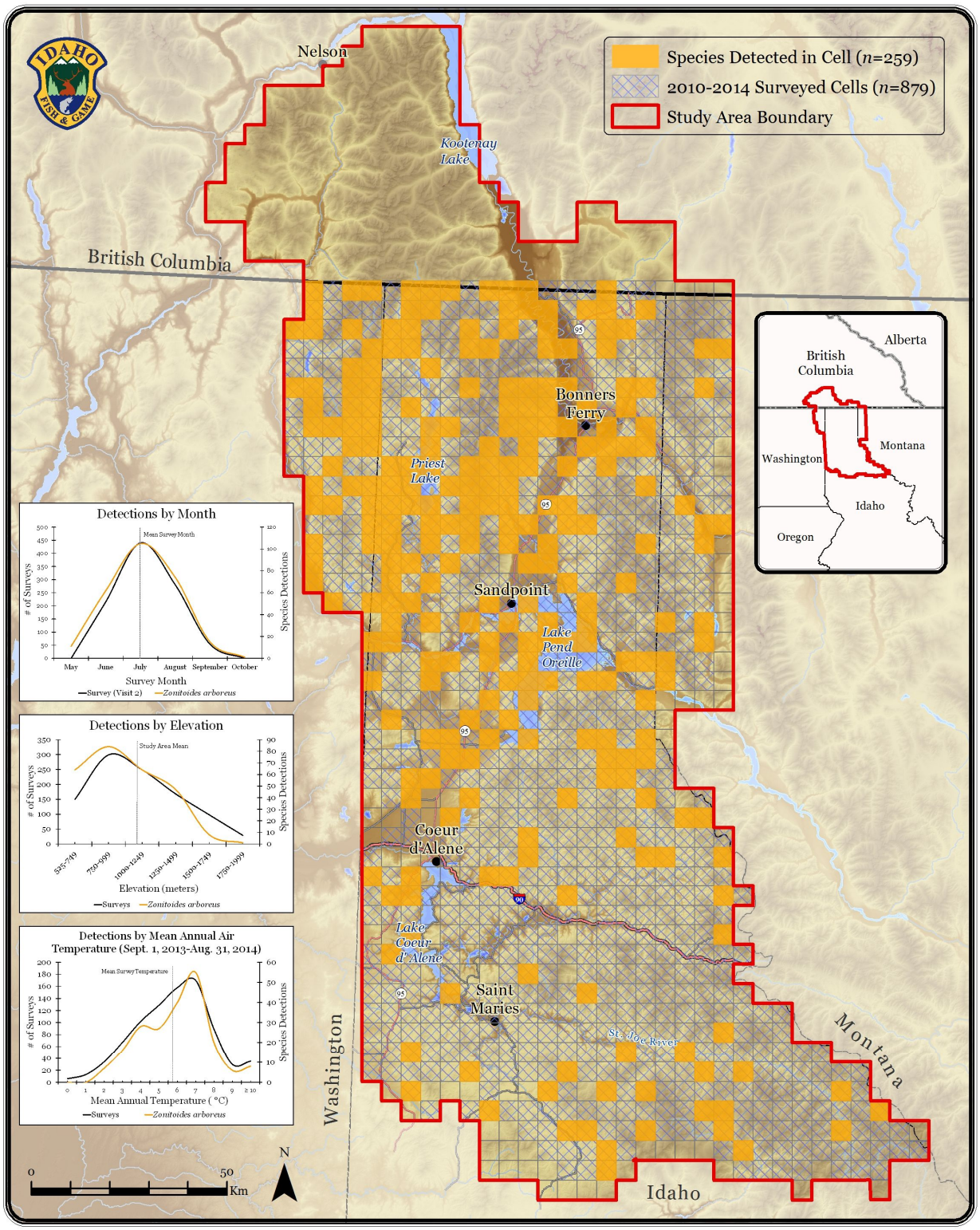
Map 2-66.

Multi-species Baseline Initiative: Sheathed Slug (*Zacoleus idahoensis*) Detections



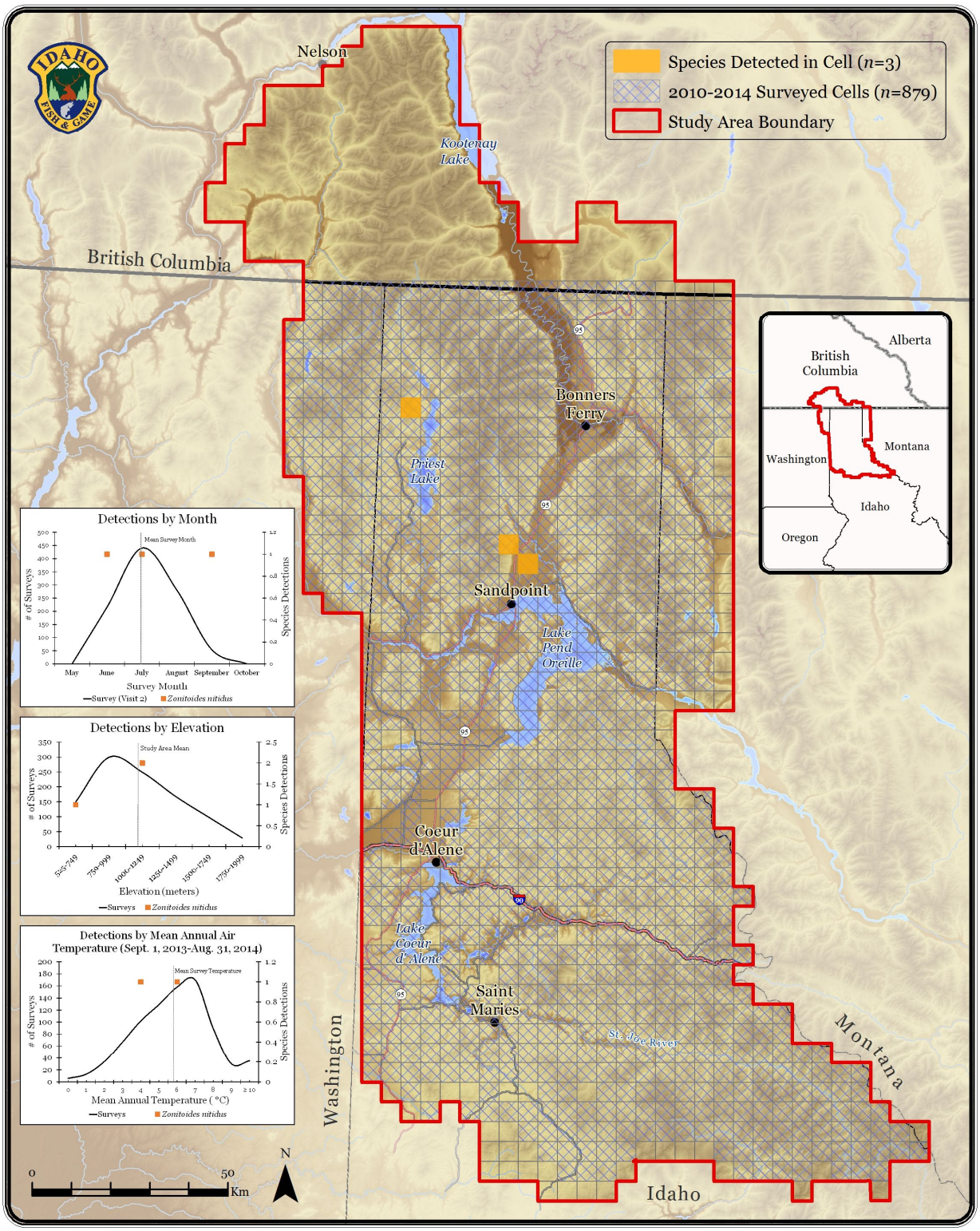
Map 2-67.

Multi-species Baseline Initiative: Quick Gloss (*Zonitoides arboreus*) Detections



Map 2-68.

Multi-species Baseline Initiative: Black Gloss (*Zonitoides nitidus*) Detections



Map 2-69.