Added *Navarretia paradoxiclara* and *Navarretia paradoxinota* to California Rare Plant Rank 1B.3 of the CNPS Inventory on April 27, 2016

Rare Plant Status Review: *Navarretia paradoxiclara* and *Navarretia paradoxinota*
Proposed Addition of *N. paradoxiclara* to California Rare Plant Rank 1B.3, G2 / S2
Proposed Addition of *N. paradoxinota* to California Rare Plant Rank 1B.3, G2 / S2

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Changes made to the original document are in blue text.

Background

Navarretia paradoxiclara L.A. Johnson & D. Gowen and *N. paradoxinota* L.A. Johnson & D. Gowen are taprooted annual herbs in the Polemoniaceae known from Tuolumne and Calaveras counties (*N. paradoxiclara*) and Colusa, Lake, and Napa counties (*N. paradoxiclara*), California. They are included in Supplement I of the *Jepson Manual, Second Edition* (Johnson 2013). The Polemoniaceae treatment for the *Flora of North America* (Volume 15) is not yet available. *Navarretia paradoxiclara* and *N. paradoxinota* are very similar to, and previously collected as, *N. intertexta*, with which they are also sympatric. Although these two novel taxa vary only slightly from *N. intertexta*, their morphological differences are consistent, and they show significant genetic differences as well. In order to assess degrees of divergence, Johnson et al. (2013) analyzed DNA sequence data from twelve populations of *N. intertexta* and five populations each of *N. paradoxiclara* and *N. paradoxinota* from across their range. They also included six additional species representing the diversity of *Navarretia* section *Navarretia* for a total of 31 populations sampled. Upon sequencing three chloroplast regions, three nuclear ITS regions, and a portion from the nuclear *Pistillata* (*PI*) region, Johnson et al. (2013) revealed an early divergence of *N. paradoxiclara* and *N. paradoxinota* from their common ancestor with *N. intertexta*. Though sequencing revealed a substantial anagenic change, the three surveyed DNA regions recovered somewhat different sister relationships that were not strongly supported. However, more thorough taxon sampling recovered similar and more strongly supporting relationships with cpDNA and ITS sequences, with *PI* placing the new species nearer to *N. tagetina* and *N. subuligera* (Johnson et al. 2012; Johnson et al. 2013). The alternative hypotheses are thought to "reflect a rapid diversification following divergence obscuring synapomorphy, early homoploid hybridization, or lineage sorting of ancestral polymorphisms" (Johnson et al. 2013). In conclusion, Johnson et al. (2013) state:

> "The denser population sampling of *Navarretia paradoxiclara*, *N. paradoxinota*, and *N. intertexta* here, compared to Johnson *et al.* 2012[…], affirms consistency between morphological and molecular results in supporting not only differences between both new species and *N. intertexta*, but also the distinctiveness of the new species with respect to each other. *PI* sequences provide evidence for reciprocal monophyly between *N. paradoxiclara* and *N. paradoxinota.* Weaker differentiation in the surveyed cpDNA and ITS regions does not recover

> reciprocally monophyletic lineages, but neither does it strongly reject this hypothesis for these two species."

Johnson et al. (2013) compared morphology of the new species and *N. intertexta* under a framework of population aggregate analysis/specimen aggregate analysis using specimens from field work and herbarium visits to, or loans from, BRY, CAS, CPH, IDS, RSA, and JEPS. They examined two to five individuals per population from five populations of each species. They found that the morphological differences between *N. intertexta*, *N. paradoxiclara*, and *N. paradoxinota* are minimal, yet the minute differences are consistent. In pressed, dried specimens, both *N. paradoxiclara* and *N. paradoxinota* have anthers that reach but do not exceed the corolla tips. When flowers are fresh, this feature is more obvious in *N. paradoxinota* than *N. paradoxiclara*, and in the former species the corolla lobes are ascending and from the top the anthers appear to be just beyond the throat (versus anthers appearing more strongly exserted due to bigger anthers, lager corollas, and corolla lobes that are more often presented at right angles to the corolla tube or even slightly reflexed in *N. paradoxiclara*). Stamens of *N. intertexta* are always strongly exserted with anthers presented beyond the corolla lobe tips when pressed and fresh. *Navarretia paradoxiclara* is differentiated from *N. paradoxinota* and *N. intertexta* in having large corolla lobes that generally exceed all calyx lobes (versus corollas may or may not exceeding the calyx lobes). *Navarretia paradoxiclara* also has pale blue (fading to white) corollas that are similar to *N. intertexta*'s corollas, which vary towards white suffused with blue, but different from *N. paradoxinota*'s corollas which are plain white. All three species have calyx lobes that are unequal and generally entire, with one or two lobes that may be two or three pronged. Pronged calyx lobes are variable in number per head in *N. intertexta*, but are infrequent in *N. paradoxiclara* and *N. paradoxinota*, which appear to generally only have one calyx per head. There are geographic differences between the species as well, and although *N. intertexta* is sympatric with *N. paradoxiclara* and *N. paradoxinota*, the two new species are wholly allopatric with no signs of intergradation. Lastly, in agreement with the morphological and molecular data, *N. paradoxiclara* and *N. paradoxinota* are also edaphically divergent from *N. intertexta* as occurring on serpentine influenced soils. Although *N. intertexta* can tolerate some degree of serpentine influence, natural populations of the new species show a strong association with serpentine whereas *N. intertexta* does not (Johnson et al. 2013).

Navarretia paradoxiclara was first noticed by Johnson et al. (2013) after reviewing herbarium sheets from BRY in 2008, and subsequently collected by them in 2009. The specific epithet is derived from the Latin *paradoxus* (= contrary to expectation) and *clarus* (= bright, famous); *clarus* to honor Polemoniaceae expert Dr. Robert Patterson, and *paradoxus* referring to the unexpected degree of molecular divergence from *N. intertexta* and unexpected genetic similarity of this species to *N. paradoxinota* (Johnson et al. 2013).

Navarretia paradoxinota was first collected in 1996 by L. Johnson. Although he made the diagnostic observation that the stamens were equally exserted to the middle of the corolla lobes, it wasn't appreciated at the time, and later lab work revealed the genetic

differences between it and *N. intertexta.* As with *N. paradoxiclara*, part of the specific epithet is derived from the Latin *paradoxus* (= contrary to expectation), while *Nota* (= mark) is to honor Dr. J. Mark Porter who has substantially contributed to our present understanding of relationships in Polemoniaceae (Johnson et al. 2013).

Navarretia paradoxiclara and *N. paradoxinota* both occur in open, seasonally wet, serpentine influenced soils of drainages, meadows, and seeps, and bloom primarily from mid May to late June (early July) (Johnson et al. 2013). *Navarretia paradoxiclara* is known from an approximate elevation of 150 to 430 meters, while *N. paradoxinota* is known from a higher minimum and higher maximum elevation range of 165 to 840 meters (Johnson et al. 2013; Consortium of California Herbaria 2016).

Navarretia paradoxiclara is known from approximately twelve occurrences in western Calaveras and western Tuolumne counties. Of the twelve occurrences, over half (seven) are considered historical (occurrences not seen in over 20 years are considered historical by the CNDDB), and at least three of the historical occurrences haven't been documented in over 50 years. Most occurrences of *N. paradoxiclara* have an unknown landownership, with at least one occurrence on federal Army Corps of Engineers land, and possibly three occurrences on federal Bureau of Land Management (BLM) lands. Due to its cryptic traits and similarities to *N. intertexta*, which it is also sympatric with, there are possibly additional occurrences of *N. paradoxiclara* not currently documented. In order to estimate how many additional specimens may need to be reviewed as being potential misidentifications of *N. paradoxiclara*, the Consortium of California Herbaria (2016) was searched for specimens of *N. intertexta* from Calaveras and Tuolumne counties from herbaria not visited, or specimens not loaned, by Johnson et al. (2013). Duplicates housed in herbaria visited, or loaned, by Johnson et al. were discounted. The criterion results only brought up six specimens of *N. intertexta* from these two counties: *Helmkamp and Helmkamp 17698* (UCR, SD), *Hrusa 15483* (CDA), *Myatt 326* (UCD), *Powell 1517* (UCD), *Sharsmith 4542* (YM), and *Tilden 1607* (SJSU). None of the six collections are noted to be on serpentine influenced soils. Such a low number suggests that sufficient herbarium review was conducted by Johnson et al. (2013) in describing *N. paradoxiclara*, and also indicates that our current understanding of its distribution based on herbarium collections is well known. Johnson et al. (2013) also conducted field work in their study; however, due to its cryptic nature and in being recently described, additional field surveys of *N. paradoxiclara* could be helpful to determine the existence of any potential additional occurrences.

Navarretia paradoxinota is known from approximately seven ~~six~~ occurrences in Colusa (one occurrence), Lake (three occurrences), and Napa (three ~~two~~ occurrences) counties. Only one of its occurrences is historical (*Mason 12798*), and due to vagueness is possibly part of a larger, continuous occurrence from the same vicinity (see occurrence number 4 in the "Localities" section of the attached "NewAdd_NavarretiaParadoxinota" spreadsheet). Two occurrences of *N. paradoxinota* are on BLM land, one is on a Land Trust of Napa County, another is on Napa County Regional Park and Open Space, and the remaining three have an unknown landownership. As with *N. paradoxiclara*, there are possibly additional occurrences of *N.*

paradoxinota not accounted for due to its cryptic traits and similarities to *N. intertexta*, which it is also sympatric with. The same approach for *N. paradoxiclara* using the Consortium of California Herbaria (2016) was used to estimate how many additional specimens of *N. intertexta* may need to be reviewed as potential misidentifications of *N. paradoxinota*. In this case, the criterion results brought up approximately seventeen specimens of *N. intertexta* from Colusa, Lake, and Napa counties in herbaria not visited, or loaned, by Johnson et al. 2013. Only one specimen came up from Colusa County, *Oswald 1617* (CHSC), and was not noted to occur on serpentine. Approximately fourteen specimens came up from Lake County, with only one noted to occur on serpentine: *Smith and Sawyer 4680* (HSC); *Mason 12580* (UCD, UTC); *Crampton 578, 582, 494C, 1390* (on volcanic soil), *3656* (on basalt), and *10313* (UCD); *Hulse-Stephens 654* and *937* (UCD); *Sohulthess s.n.* (UCD); *Sanchez-Mata and Ugurlu s.n.* (UCD) (on ultramafic); *Solomeshch and Olmsted s.n.* (UCD); and *Dean et al. 6042* (UCD) (on serpentine). Lastly, two specimens of *N. intertexta* came up from Napa County: *Crampton 3470* (UCD) and *Solomeshch s.n.* (UCD). This may seem like a rather rudimental approach to determine the existence of potential additional specimens of *N. paradoxinota*, as none of the above specimens of *N. intertexta* were reviewed for potentially falling within the same range or proximity of known occurrences of *N. paradoxinota*, nor were any adjacent counties included in the search; however, it may suffice to show that Johnson et al. reviewed a significant number of specimens in describing *N. paradoxinota*. A total of 72 specimens of *N. intertexta* exist in the Consortium of California Herbaria (2016) for these three counties, indicating Johnson et al. reviewed at least 55 (over 75%) of them in describing *N. paradoxinota*. As with *N. paradoxiclara*, Johnson et al. (2013) also conducted field work in their study of *N. paradoxinota*, but additional field surveys for it could be helpful to determine the existence of any potential additional occurrences.

Threats to *N. paradoxiclara* and *N. paradoxinota* are unknown, but due to their relatively small distributions and very small number of recent occurrences, they should be considered for conservation concern. Only one to four occurrences of *N. paradoxiclara* and four ~~three~~ occurrences of *N. paradoxinota* are on protected lands, and it's unknown what potential future threats may exist for ~~to the majority of~~ their occurrences on non-protected lands.

Based on the available information, CNPS and CNDDB recommend adding *N. paradoxiclara* and *N. paradoxinota* both to California Rare Plant Rank 1B.3 of the CNPS Inventory. If knowledge on their distribution, threats, and/or rarity status changes in the future, we will re-evaluate their status at that time.

Recommended Actions
CNPS: Add *Navarretia paradoxiclara* to CRPR 1B.3;
Add *Navarretia paradoxinota* to CRPR 1B.3
CNDDB: Add *Navarretia paradoxiclara* to G2 / S2;
Add *Navarretia paradoxinota* to G2 / S2

Sent to: NW, SN, D. Gowen, L. Johnson, T. La Doux, R. O'Dell, R. Patterson, M. Porter, D. Wilken on 3/17/2016

Draft CNPS Inventory Records

Navarretia paradoxiclara L.A. Johnson & D. Gowen
Patterson's navarretia
Polemoniaceae
CRPR 1B.3
Calaveras, Tuolumne
Jenny Lind (447D) 3812017, Chinese Camp (458C) 3712074, Copperopolis (459B) 3712086, Keystone (459D) 3712075, San Andreas (476B) 3812026, Salt Spring Valley (476C) 3812016, Angels Camp (476D) 3812015, Valley Springs (477A) 3812027, Wallace (477B) 3812028
Meadows and seeps / serpentinite, openings, vernally mesic, often drainages; elevation 150 - 430 meters.
Taprooted annual herb. Blooms May – June (July)
Similar to, and sympatric with, *N. intertexta*; also similar to *N. paradoxinota*. Differentiated from both similar species in having larger corolla lobes that generally exceed all calyx lobes; also differentiated from *N. intertexta* in having anthers that reach but do not exceed corolla tips. See *Phytotaxa* 91(2):27-38 (2013) for original description.

Navarretia paradoxinota L.A. Johnson & D. Gowen
Porter’s navarretia
Polemoniaceae
CRPR 1B.3
Colusa, Lake, Napa
Aetna Springs (516B) 3812264, Detert Reservoir (517A) 3812265, Leesville (547B) 3912224
Meadows and seeps / serpentinite, openings, vernally mesic, often drainages; elevation 165 - 840 meters.
Taprooted annual herb. Blooms May – June (July)
Similar to, and sympatric with, *N. intertexta*; also similar to *N. paradoxiclara*. Differentiated from both similar species in having plain white corollas; also differentiated from *N. intertexta* in having anthers that reach but do not exceed corolla tips, and differentiated from *N. paradoxiclara* in having smaller corolla lobes that may or may not exceed all calyx lobes. See *Phytotaxa* 91(2):27-38 (2013) for original description.

Literature Cited

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Johnson, L.A. 2013. *Navarretia paradoxiclara* and *N. paradoxinota*. Revision 1, in Jepson Flora Project (eds.) *Jepson eFlora*. Website http://ucjeps.berkeley.edu/eflora/eflora_display.php?tid=98884 [accessed 2 February 2016].

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