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GUIDE TO WASHINGTON COAL LITERATURE

by

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INTRODUCTION

Since coal was discovered in Washington State in 1833, over 400 articles, reports, and maps have appeared in the technical literature describing various elements of Washington coal geology. In addition, a large group of published accounts treat aspects of regional geology, such as structure and stratigraphy, that are vital for planning or conducting coal mining, exploration, and research. This report is designed to serve as a guide to this complex body of literature. Provided are a comprehensive coal bibliography, and geological and geophysical map indexes for prospective and known coal-bearing areas. The map indexes and bibliography are current through 1982.

Geologic mapping has been outlined on four sheets separated by scale (plates 1-4). The scales represent original mapping at scales ranging from 1:480 to 1:500,000 as issued in published and open-file reports and theses. All original map outlines shown on the map index sheets are keyed to corresponding references in Appendix A. Geophysical mapping has been outlined on one sheet and the original map outlines presented thereon are keyed to corresponding references in Appendix B.

BIBLIOGRAPHY AND INDEX COMPILATION

The comprehensive coal bibliography was compiled primarily from Manson (1981, 1980), Reichert (1979, 1969, 1960), Livingston (1974), Bennett (1939), O'Donnell (1913), and Landes (1901). Bibliographies contained in Beikman and others (1961), Nielsen (1983), and Choate and Johnson (1980) were also extensively consulted. In addition, reference lists generated by the GeoRef computerized bibliographic system and by several coal researchers (see acknowledgements) were used.

Most of the references cited in the coal bibliography were examined to determine their relevance to Washington coal geology. These references are contained in the Division of Geology and Earth Resources library and are available for inspection. References not examined are not part of the Division's library collection and are indicated by an asterisk in the bibliography.

The geologic and geophysical map indexes were compiled from Manson (1981, 1980). Rather than being exhaustive, the indexes document published maps considered relevant to Washington coal geology by the authors of this report. No attempt has been made to show available mapping in all areas containing isolated occurrences of coal. Hence, the map indexes concentrate upon western and central Washington coal-bearing areas where nearly all of the state's known coal resources are found.

ACKNOWLEDGEMENTS

Coal bibliographies prepared by F. F. Foit, Washington State University, and J. L. Lindberg, Getty Oil Company were used extensively in preparing this report. C. J. Manson, Senior Librarian of the Division of Geology and Earth Resources, also assisted with preparation of this guide.

GEOGRAPHIC AND GEOLOGIC SETTING OF WASHINGTON COAL DEPOSITS

The most useful overview of the occurrences, resource estimates, and quality of Washington coal is presented in Beikman and others (1961). Coal data published since 1961 are summarized by Nielsen (1983). A brief discussion of the geographic and geologic setting of Washington coal deposits is also presented here in order to introduce place names and stratigraphic nomenclature used in Washington coal literature.

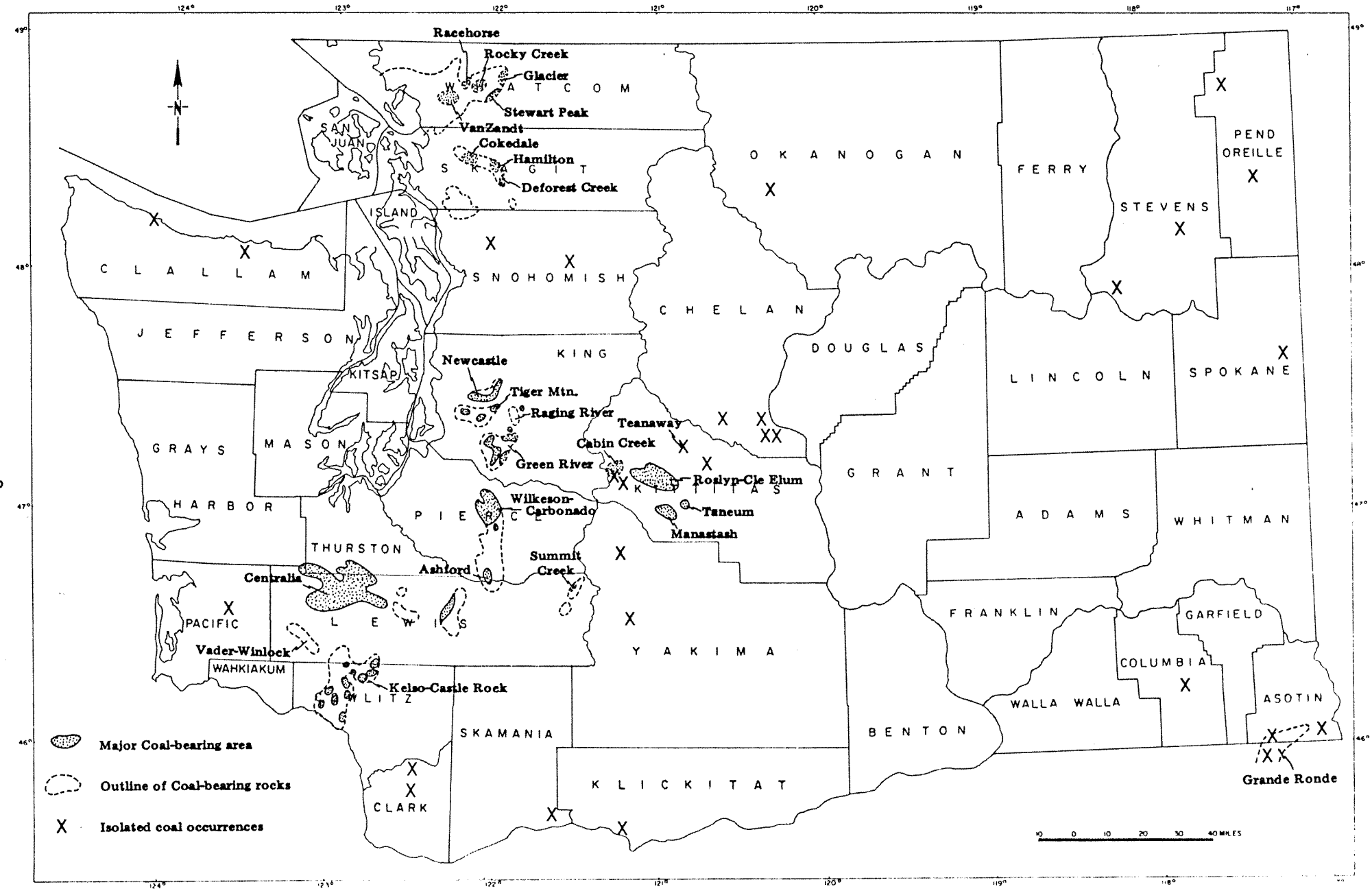

FIGURE 1. – Index map of Washington showing major coal-bearing areas and isolated coal occurrences.

Most of the principal coal deposits in Washington occur in a discontinuous belt extending along the western edge of the Cascade Range from the Columbia River northward nearly to the Canadian border. Notable exceptions are the Kittitas County coalfields on the east flank of the Cascades in the central part of the state. In addition, coal occurs in many small, isolated areas throughout the state. The locations of the major coal-bearing areas and of the isolated occurrences of coal are shown in figure 1.

With the exception of several thin beds of semianthracite in rocks of pre-Tertiary age on Orcas Island in San Juan County, all coal in the state is of Tertiary age. The Chuckanut Formation in northwest Washington was formerly thought to contain rocks of Cretaceous age at its base. Recent work indicates however, that the Chuckanut may be comprised entirely of Tertiary age rocks (Johnson, 1982; Reiswig, 1982; Frizzell, 1979).

In the eastern portion of the Puget Lowlands the coal-bearing rocks were principally deposited in Eocene to Oligocene delta systems, prograding into a northerly to northwesterly trending embayment (Buckovic, 1979). The coal-bearing rocks commonly interfinger with, and grade into, marine non-coal-bearing rocks to the west (Beikman and others, 1961). Contemporaneous local volcanism commonly contributed ash to many coal seams in the form of tuffaceous partings. East of the Puget Lowlands, coals of the Kittitas County fields were deposited in Eocene fluvial or lacustrine settings also characterized by local volcanism (Walker, 1980). Figure 2 shows the age and suggested correlations of the lower Tertiary rocks which contain the bulk of Washington's coal resources. In addition, there are numerous isolated occurrences of lignite which formed as lacustrine interbeds between flows of the Miocene Columbia River Basalt Group (Stoffel, 1981). References pertinent to one such occurrence, the Grande Ronde field of Asotin County, are presented in this report.

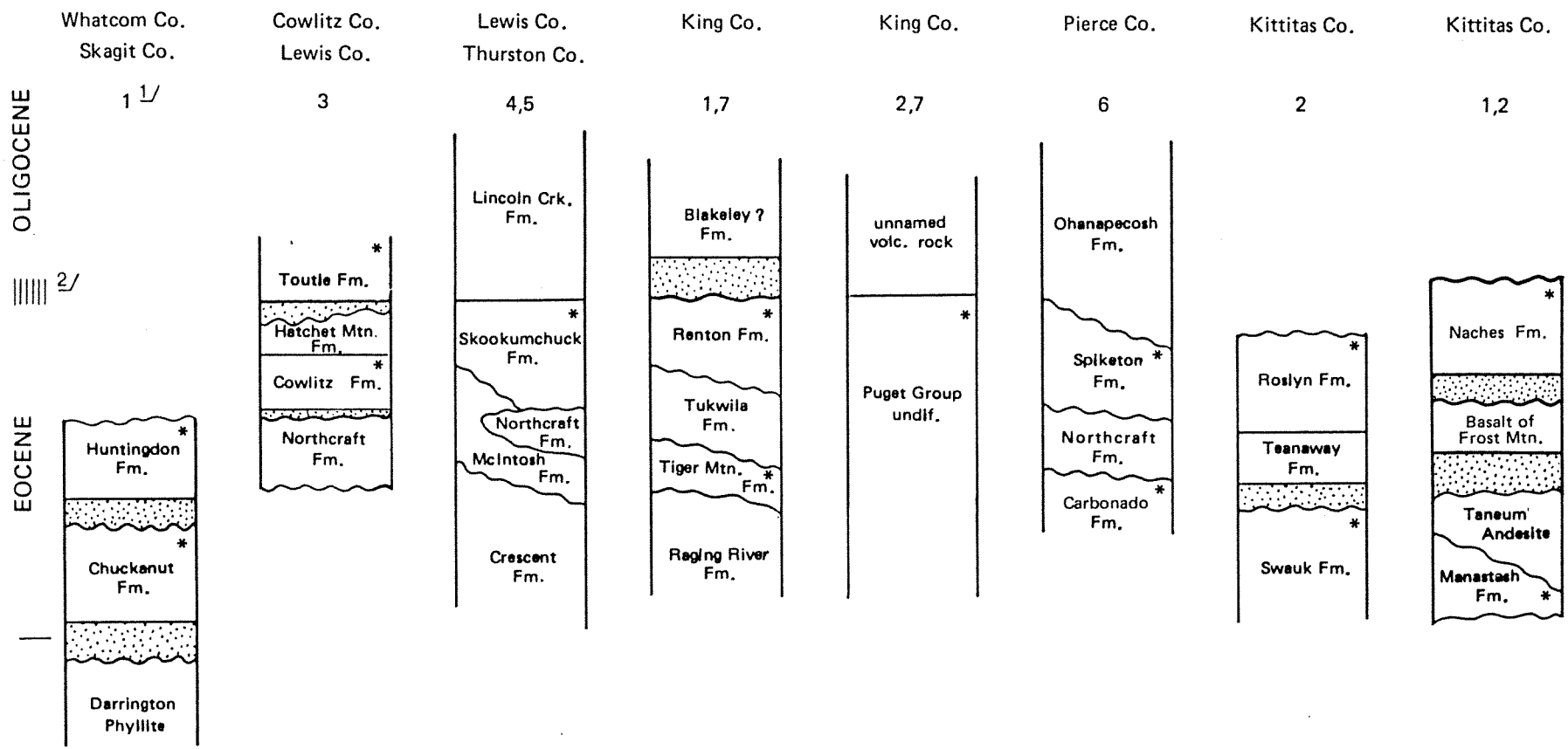

FIGURE 2. — Age and suggested correlations of some lower Tertiary rock units in Washington (asterisks indicate coal-bearing formations; stippled areas represent unconformities).

1/ Each column is modified from the following sources: 1 - Frizzell (1979); 2 - Newman (1981); 3 - Roberts (1958); 4 - Rau (1981); 5 - Snavely and others (1958); 6 - Gard (1968); 7 - Vine (1969).

2/ The broad Eocene-Oligocene boundary represents the evolving views of its placement by the various authors whose conventions are followed in this table.

The rank of western and central Washington coal, as estimated from hundreds of proximate and ultimate analyses of face-channel samples (Daniels and Yancey, 1958; Cooper and Abernathy, 1941; Fieldner and others, 1931) ranges from lignite to anthracite. In general, coal rank increases markedly toward the crest of the Cascade Mountains, probably as a result of widespread Oligocene-Miocene igneous activity (Walsh and Phillips, 1983). A small amount of anthracite occurs close to the Cascade Mountains. Coal rank is typically bituminous within about 40 miles (65 km) of the mountain range, decreasing to sub-bituminous and lignitic coal in the Puget Lowlands of southwestern Washington.

Ash content of Washington coal is usually high enough to require washing after mining. Ash values reported in Nielson (1983) range from 2.0% to 45.7%. The sulphur content of these coals is typically less than 1%. Coals suitable for coking are found in the Wilkeson-Carbonado field and Ashford area of Washington (Yancey and others, 1939).

Much of the bituminous, and all of the anthracite coal resources of Washington are contained in rocks that have undergone considerable tectonism. Structural complexity in terms of faulting and folding tends to increase, like coal rank, with proximity to the Cascade Mountains. Because steeply dipping seams are common in many coal-bearing areas, strip mining is not considered feasible in much of Washington. Furthermore, in some mines, variation in dips of coal seams required more than one method of mining to remove the coal (Beikman and others, 1961). However, large-scale strip mining (4 to 5 million tons per year) of sub-bituminous coal has been successful in the Centralia area for over 10 years (Paul, 1980).

Coal mining and exploration is also complicated throughout much of western Washington by glacio-fluvial deposits. During the Pleistocene, the Puget Lobe of the Cordilleran ice sheet repeatedly occupied the Puget Lowlands, as far south as the Olympia area, depositing a variety of unconsolidated sediments (Easterbrook, 1979). Thickness of the sediments is very irregular in many coal-bearing areas due to pre-Pleistocene topography and differential glacial and meltwater scour. In general, the thickness of unconsolidated sediments increases toward the axis of the Puget Lowlands (Hall and Othberg, 1974). Because of the need to predict the thickness of overburden for mining or exploration projects, many references concerned with Quaternary mapping and stratigraphy have been included in the geologic map index of this report.

Estimated reserves of Washington coal as of January 1, 1983 are presented in Table 1.

Table 1: Estimated reserves of coal in Washington State as of January 1, 1983.

Rank	Millions of Short Tons
Anthracite	5
Bituminous	2,099
Sub-bituminous	4,135
Lignite	132
TOTAL:	6,371

Source: Nielson (1983)

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Appendix A

Index to Geologic Mapping

GEOLOGIC MAPPING

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15.b. Plate XII, Coal Bank Rapids area, scale 1:63,360.
15.c. Plate XIII, Vader area, scale 1:63,360.
15.d. Plate XV, Centralia-Chehalis area, scale 1:63,360.
15.e. Plate XVI, Tenino-Mendota area, scale 1:63,360.
15.f. Plate XIX, Cinnabar area, scale 1:63,360.
15.g. Plate XX, Mineral Lake area, scale 1:63,360.
15.h. Plate XXII, Ashford area, scale 1:63,360.

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Appendix B

Index to Geophysical Mapping

GEOPHYSICAL MAPPING

1. Bechtel, Inc., 1979, Report of geologic investigations in 1978-1979, Skagit Nuclear Power Project: Puget Sound Power and Light Company, 3 volumes.
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Appendix C

Washington State Coal Bibliography

NOTE

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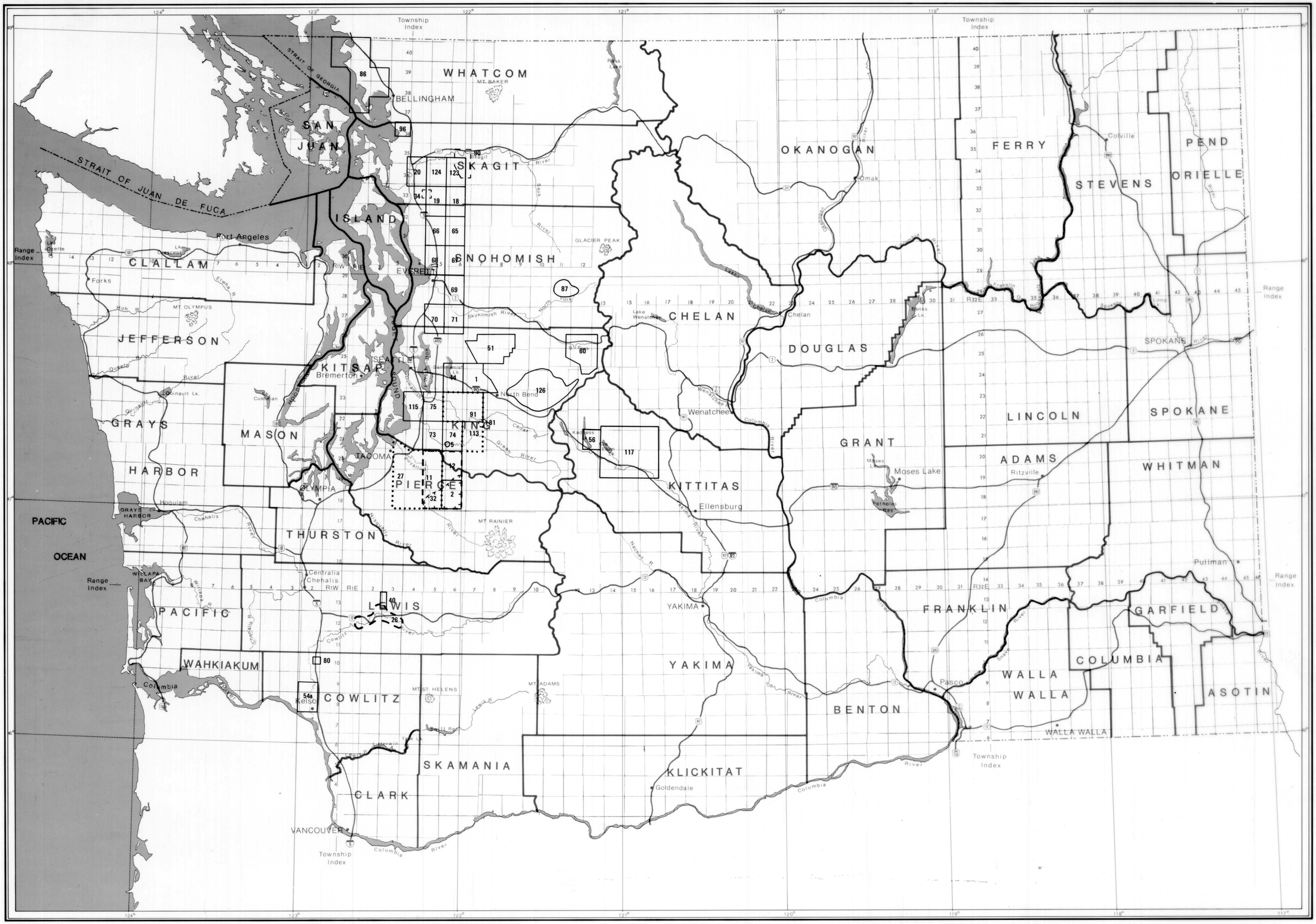
WASHINGTON DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGY AND EARTH RESOURCES

OPEN-FILE REPORT 83-6, PLATE 1



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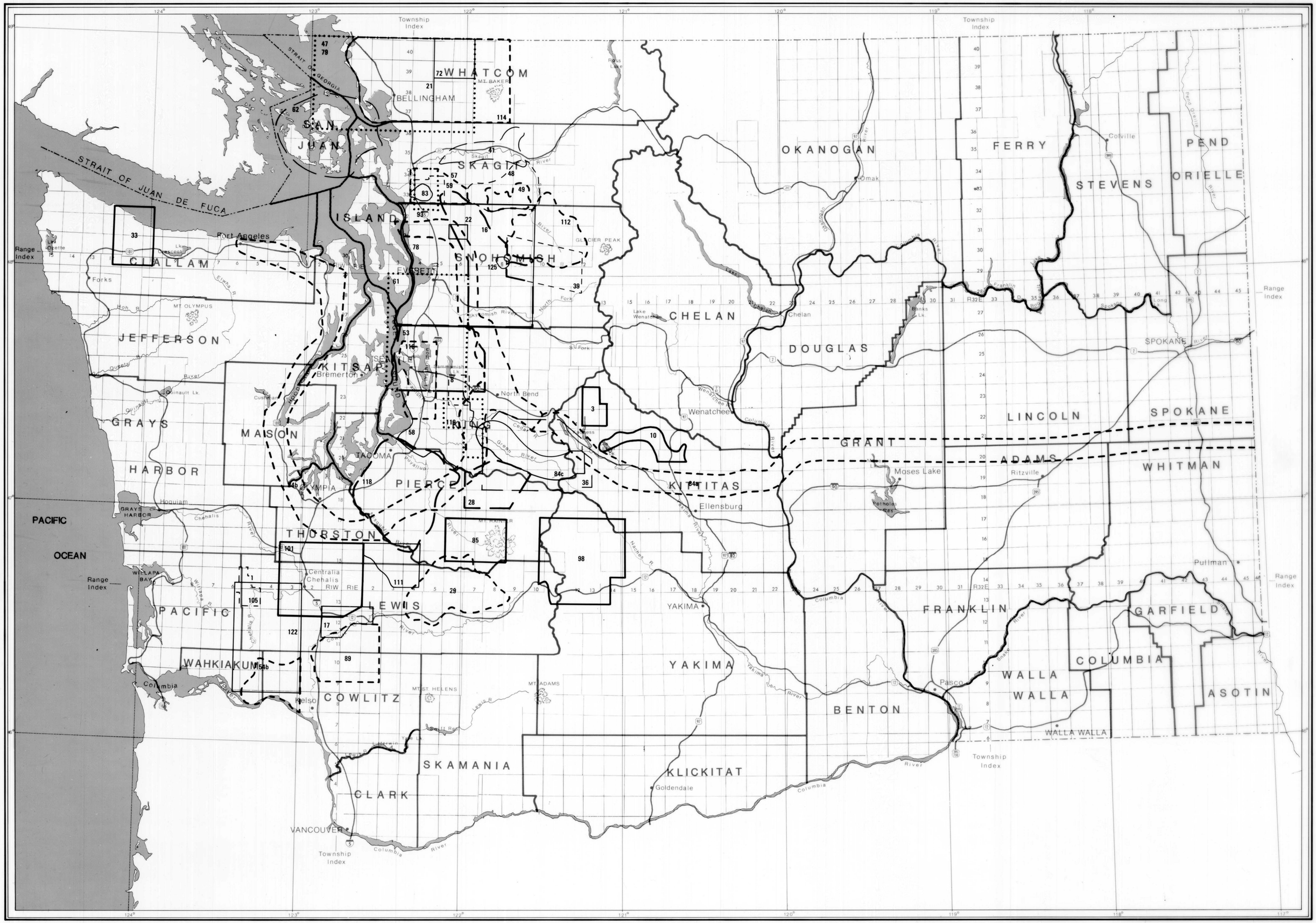

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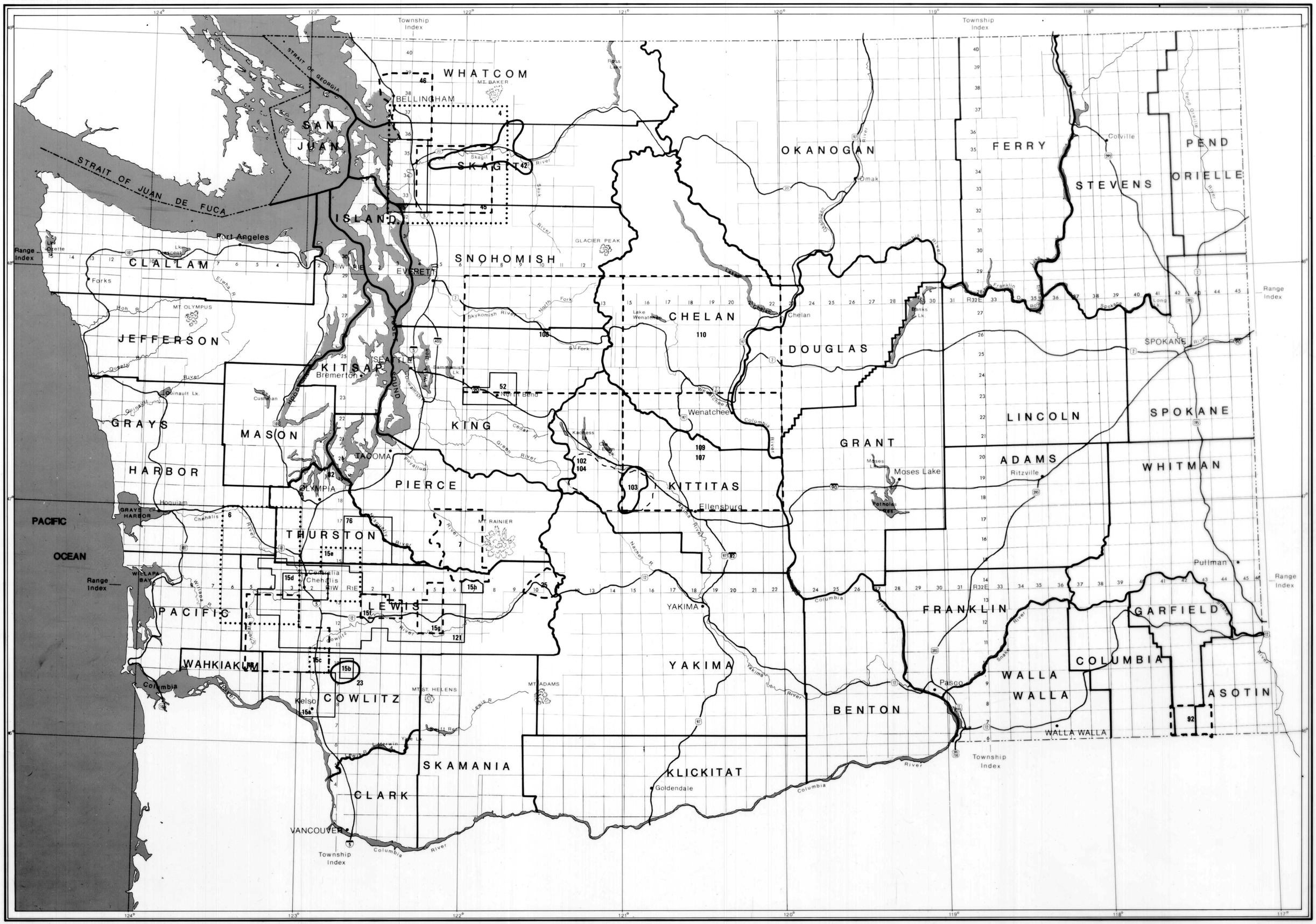

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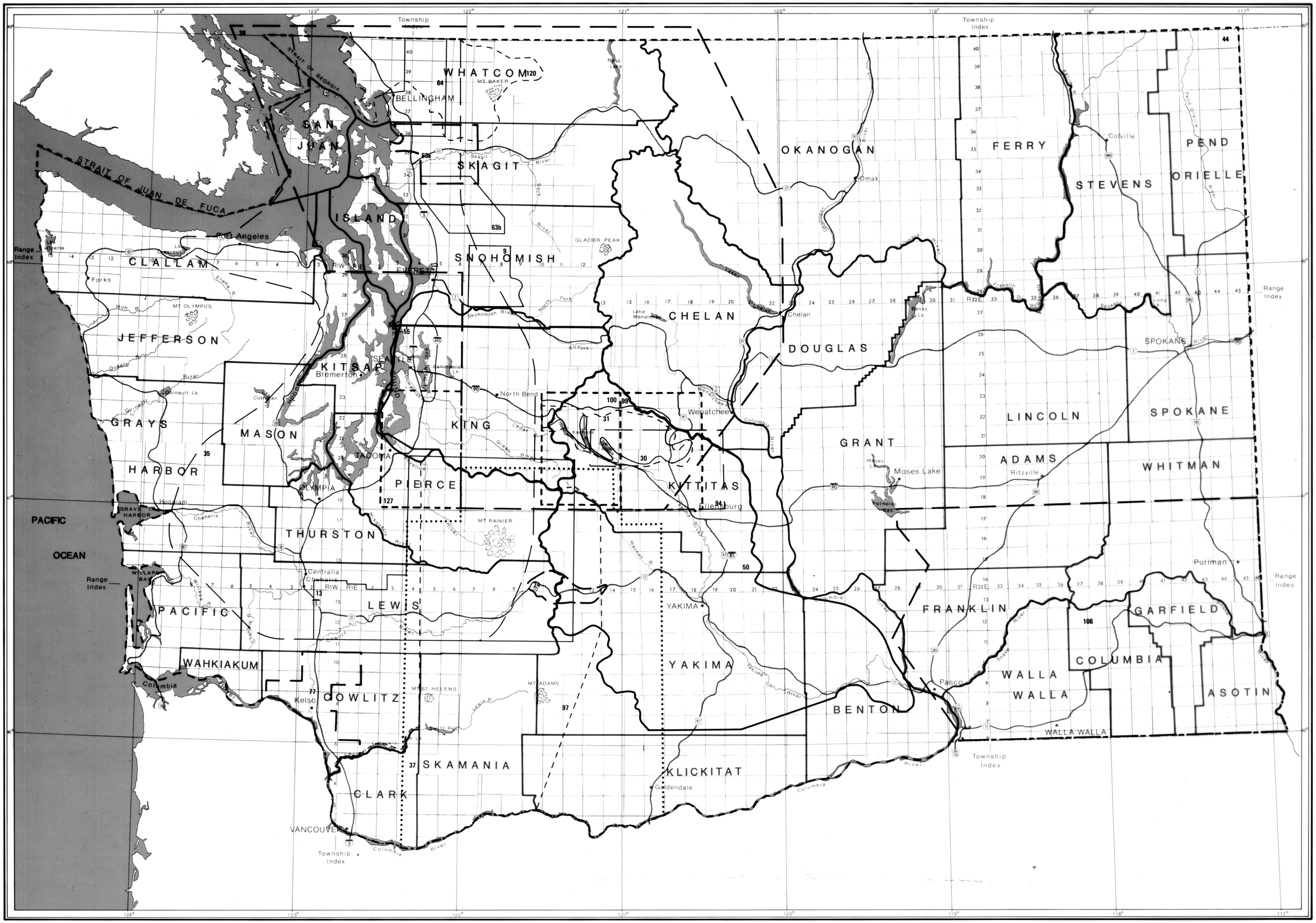

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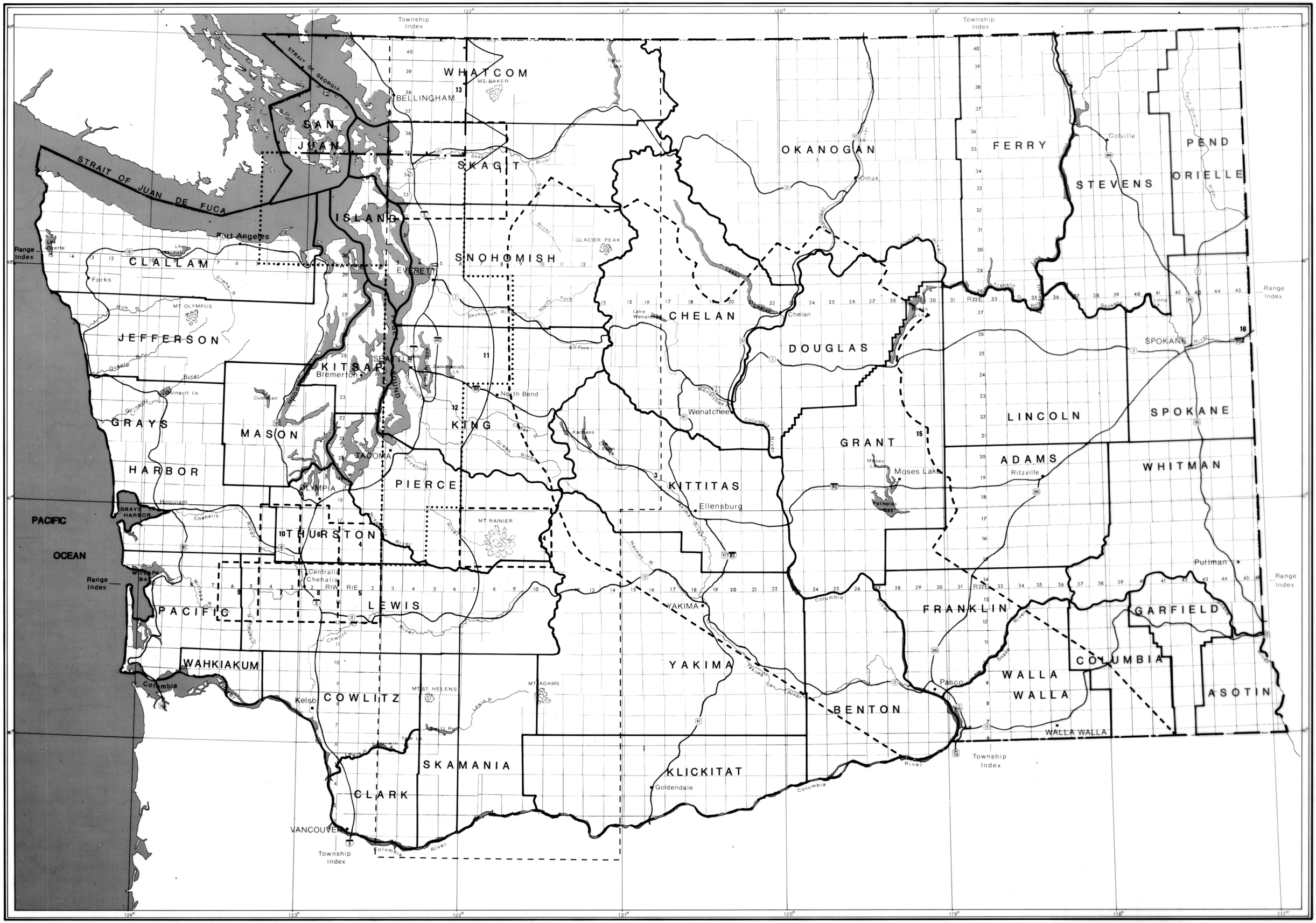

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