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RECOVERY POTENTIAL ASSESSMENT FOR THE OKANAGAN POPULATION OF CHINOOK SALMON
(Oncorhynchus tshawytscha)

Okanagan Chinook (2006 spawning season from Davis et al. 2007.)

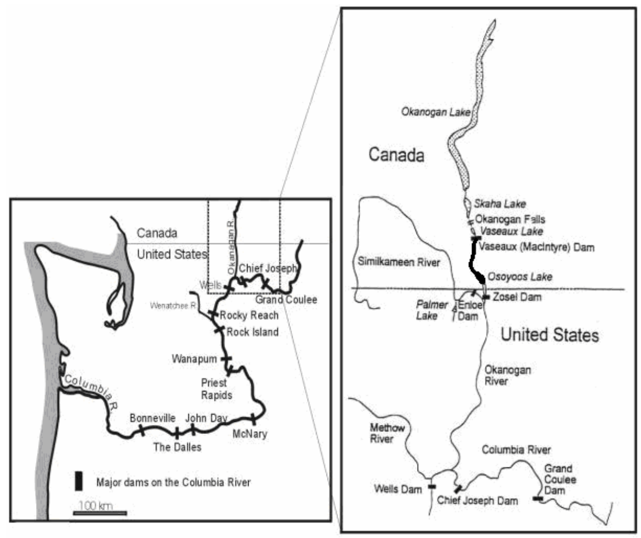

Figure 1: Distribution map for Okanagan Chinook, from Davis et al. 2007.

Context

Recovery Potential Assessments have been established by the Department of Fisheries and Oceans to assess the biological basis for survival or recovery of the species, incidental harm permitting, subsequent socio-economic analyses, recovery planning and advising the Minister on listing decisions. In May, 2005 the Canada portion of the Okanagan Chinook salmon population was designated as endangered in an emergency assessment by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). In April 2006 the status of the population was re-examined by COSEWIC and it was designated as threatened. This more recent assessment was based on genetic analysis that indicated there was potential of rescue from populations in adjacent areas of the Columbia River basin. The population of less than 50 spawners was considered susceptible to extinction from habitat loss in Canada, juvenile and adult mortality due to U.S. dams on the Columbia River, fisheries exploitation, new predators and competition from non-native fishes. The Canadian population of Okanagan Chinook spawns within the Okanagan River and is the last remaining Canadian population of the upper Columbia River summer/fall run Chinook. A final decision on whether this population will be legally listed under Schedule 1 of the Species at Risk Act (SARA) is pending.

SUMMARY

- Okanagan Chinook were designated as threatened by COSEWIC in April 2006.
- The peak count of Okanagan Chinook spawners since 1977 was 35 in 2006. The next highest count was 29 in 2005.
- Three alternative hypotheses have been put forward to explain the degree of isolation and uniqueness of the population: 1) Okanagan Chinook are demographically isolated and ecologically non-exchangeable, 2) they are demographically isolated but ecologically exchangeable, and 3) they are not demographically isolated and they are ecologically exchangeable with U.S. Chinook in the Columbia River system.
- Okanagan Chinook are genetically similar to other upper Columbia River stocks such as the Similkameen stock.
- The level of allelic diversity in the Okanagan population is not indicative of a small inbred population, but instead they appear to have the same level of genetic diversity as seen in the larger U.S. population. This supports the conclusion that there is gene flow from the larger population and the Okanagan population is not genetically isolated.
- The weight of evidence indicates that the existing Canadian population is maintained in part by strays from the U.S. population and that rescue from this larger population is possible.
- A demographically isolated spawning population of Chinook can not be maintained without large-scale hatchery augmentation due to the high mortality rate associated with U.S. dams.

BACKGROUND

The Species at Risk Act (SARA) provides legal protection to species listed in Schedule 1. If Okanagan Chinook are listed, prohibitions under SARA would apply to this population. Activities that would harm the species would be prohibited and a recovery plan would be required. Until a recovery plan is available, section 73(2) of SARA authorizes the competent Minister to permit otherwise prohibited activities affecting that species, its critical habitat, or its residences. Under section 73(2) of SARA, authorizations may only be issued if: (a) the activity is scientific research relating to the conservation of the species and is conducted by qualified persons; (b) the activity benefits the species or is required to enhance its chance of survival in the wild; or (c) affecting the species is incidental to the carrying out of the activity. Section 73(3) establishes that authorizations may be issued only if the competent Minister is of the opinion that: (a) all reasonable alternatives to the activity that would reduce the impact on the species have been considered and the best solution has been adopted; (b) all feasible measures will be taken to minimize the impact of the activity on the species or its critical habitat or the residences of its individuals; and (c) the activity will not jeopardize the survival or recovery of the species. Decisions made on permitting of incidental harm and in support of recovery planning need to be informed of the impact of human activities on the species, alternatives and mitigation measures to these activities, and the potential for recovery. An evaluation framework, consisting of three phases (species status, scope for human–induced harm and mitigation) has been established by DFO to allow determination of whether or not SARA incidental harm permits can be issued. The information in this Science Advisory Report is based on information reviewed by the Pacific Scientific Advice Review Committee (PSARC) October 25, 2007 (DFO 2007). Readers are referred to Davis et al. (2007) for many of the details otherwise summarized in this report.

Species biology

Chinook salmon display a diversity of life history traits. The Okanagan Chinook is considered to be an Upper Columbia River summer/fall population. Returning adults usually enter the upper Columbia watershed in June or July. They may hold in cooler lake waters until ready to spawn. Peak spawning in the Okanagan River is typically in the third week of October. The female constructs a redd (or depression) to contain her eggs and after fertilization by attending male(s) the redd is covered. Eggs and alevins spend the winter in the gravel and fry emerge in April and May. It is likely the fry immediately move downstream into Osoyoos Lake or move further downstream to rear. Migration patterns and habitat usage specific to Okanagan Chinook fry and juveniles are unknown. Based on case histories of other similar stocks we suspect that most subyearlings will migrate downstream from April to June during their first year. Some Okanagan Chinook (verified for males only) exhibit a non-anadromous life strategy that has been reported as unique (COSEWIC 2006). To reach the Okanagan River, adult Chinook must ascend nine U.S. dams situated on the main-stem Columbia River. To reach the ocean, anadromous Chinook juveniles must pass downstream through the same dams and hydro-modified river sections. Considerable mortality occurs during both migrations. At this time there is a series of both ocean and freshwater fisheries targeting Columbia River Chinook.

ASSESSMENT OF CURRENT SPECIES STATUS

Genetic description

Okanagan Chinook are genetically different from all other Canadian stocks (COSEWIC 2006) but are similar to neighbouring upper Columbia summer/fall Chinook populations in the U.S. A genetic comparison of Canadian Okanagan Chinook with upper Columbia summer Chinook revealed a low level of genetic differentiation among the populations and infers that Canadian Okanagan fish are evolutionarily closely related to the U.S. populations. The level of allelic diversity and heterozygosity in the Okanagan population is similar to the levels seen in the larger U.S. Chinook. This result is not indicative of a small inbred population, but instead supports the conclusion that there is gene flow from the larger meta-population and that the Okanagan Chinook are not genetically isolated. Straying of marked U.S. hatchery fish into Canada has been observed (COSEWIC 2006). Thus, the genetic assessment indicates that the existing Canadian population is maintained in part by strays from the larger American population and that rescue from this larger population is possible. Chinook salmon have successfully spawned in the Canadian portion of the Okanagan River and a few parents have been successful in producing returning offspring. Adults returning to Canada have originated from a few families as the progeny of these families were disproportionately represented and many of the progeny were siblings or half-siblings.

Trends and current status

Abundance

A general decline in upper Columbia Chionook stocks was apparent in the late 1800's possibly due to increases in human settlement within the basin and following the start of commercial harvest in 1818. Catch estimates of Chinook peaked in 1883 at 2,300,000 fish. In 1939 most upstream passages to the upper Columbia were blocked for 5 years by the Rock Island Dam.

The summer Chinook fishery was closed in 1965 and the spring Chinook fishery was closed in 1977. Spawning estimates (redd counts) have indicated that since 1999 spawning numbers have been increasing. This may be linked to improved ocean survival in recent years and to reduced downstream mortality associated with improved flow conditions during downstream migration.

The historic Okanagan Chinook population was numerous enough to support a food and trade fishery. Numbers have declined from historic levels. Chinook have been intermittently documented in the Canadian Okanagan River since 1975 (Figure 2). In the past decade, estimated annual Chinook escapement has always been below 40 fish. During the last three years, escapement has ranged from 25 to 36 spawners. The abundance of fish in the Canadian Okanagan River appears to be correlated with escapement estimates made for the U.S. portion of the Okanagan and Similkameen Rivers.

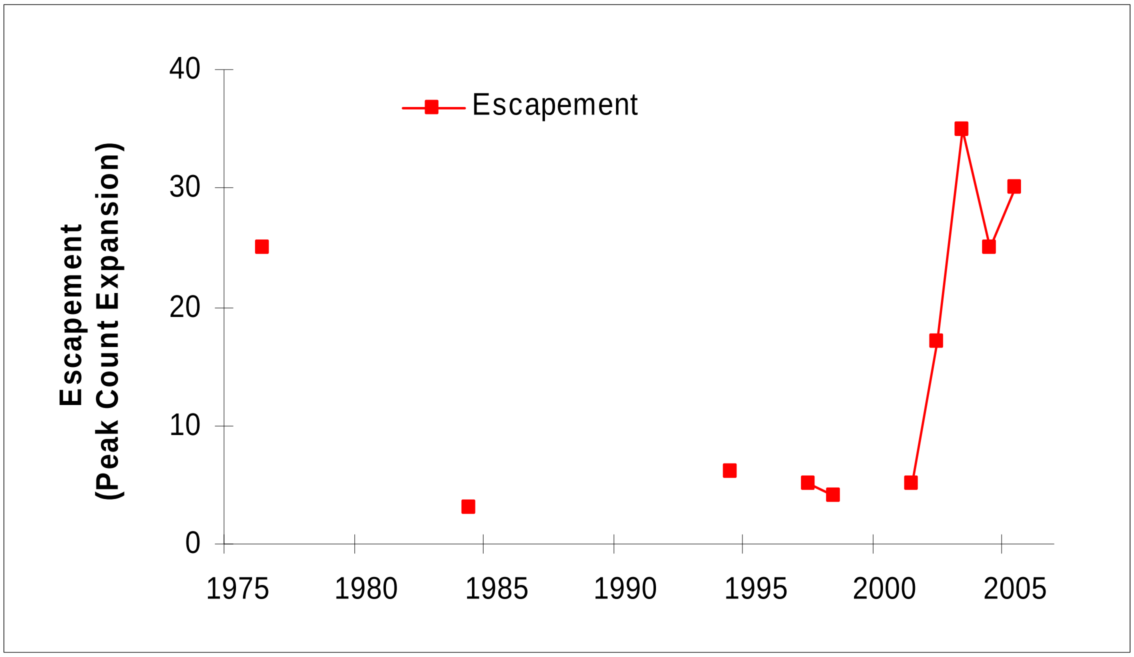

Figure 2. The escapement of Chinook to the Canadian Okanagan River (1975-2005).

U.S. hatcheries have played a major role in Chinook production in the Columbia River with the goal of increasing the harvest. In 1988 over 160 million juveniles were released. Hatchery contributions during the period 1999-2002 were estimated to represent 56% of the upper Columbia escapement (COSEWIC 2006). In the past decade, up to 1 million yearlings and sub-yearlings have been stocked annually within the U.S. portion of the Okanagan basin. Marked U.S. hatchery fish have been caught within the Canadian Okanagan River in the Columbia system. A proposed U.S. hatchery below Chief Joseph Dam will further increase the numbers of hatchery produced Chinook.

Range

The historic range of Chinook within Canada extended further upstream than it does now and was possibly 3-4 times the current range. First Nations have reported that Chinook were heavily fished at the outlet of Skaha Lake and returning adult salmon would ascend the Okanagan River into Vaseaux and Okanagan Lake. The McIntyre dam, at the outlet of Vaseaux

Lake, was built in 1921 and as currently operated represents the furthest possible upstream extent of Chinook passage. Chinook could be returned to their historic range through the operation of a fish passage facility at the McIntrye dam. At present the spawning habitat below the dam is not fully utilized.

<u>Habitat capacity</u>

Canadian Chinook habitat extends from the McInyre dam (a water control structure) to the U.S. border. This represents a total area of 16 km^2 of river and lake with varying degrees of habitat suitable for spawning and rearing Chinook. The total assessable length above the border is approximately 32 km of which 10.5 km is lake and 21.5k m is river. An 8.5 km non-engineered section remains below the McIntyre Dam and this includes a 4.5 km “natural” segment immediately below the dam and another 4.0 km dyked but “semi-natural” segment. Chinook spawning has been observed in 3.5 km of this upper river section. The lower river from 1.6 km above Oliver to Osoyoos Lake was channelized in 1957. Ongoing research activities conducted by the Okanagan Nation Alliance are designed to characterize spawning habitat, especially the role of groundwater, and establish the locations of Chinook rearing. At present spawning habitat does not appear to be a limiting factor for the few adults returning and the current spawning capacity is likely above any recovery targets set in the near future. Estimates of the amount of spawning habitat indicate there is sufficient habitat for 1,460 to 4340 naturally spawning pairs. Based on these estimates the current amount of spawning habitat is not limiting population growth. The distribution of rearing fish, their numbers, residency time, and densities are unknown. Our understanding of the movements of Chinook fry and juveniles following emergence is also very uncertain. Thus, we can not estimate the capacity of rearing habitat.

Characteristics of recovery

Recovery targets of population size and time frames for recovery are difficult to develop without a clear understanding of the biological characteristics of the Canadian Okanagan population. The following three alternative hypotheses capture the potential degree of isolation and uniqueness of the population:

1. The Canadian population is both demographically isolated and ecologically non-exchangeable with U.S. populations. For example, the Canadian population might have persisted in the face of the dire threats from dams and fisheries because of its adaptations for non-anadromy, either as a largely self-perpetuating resident population, or as a polymorphic anadromous/resident population. If these adaptations are unique, the population should be regarded as non-replaceable.

2. The Canadian population is demographically isolated but genetically closely related and ecologically exchangeable with U.S. populations. In this scenario, adaptations for residency are not unique or they contribute negligibly to the viability or ecological role of this population in Canada.

3. The Canadian population is not demographically isolated from U.S. populations. Because at least some reproduction occurs in Canada (fry and residents have been observed from 2 or 3 brood years), the population should be considered a Canadian “wildlife species”, but its fate will depend on immigration from the USA.

Each of these hypotheses has important implications for recovery. Based mainly on the weight of genetic evidence, Hypothesis 3 is considered the most likely but more research is required to definitively reject one or more of the alternative hypotheses. Support for Hypothesis 1 would be enhanced if a persistent abundance of female residents were discovered or could be inferred (e.g. ablation studies). Preliminary ablation studies to assess if juveniles in freshwater originated from resident parents is suggestive of non-anadromous Okanagan Chinook. Research directed at determining strontium:calcium ratios of females, in particular, could be important for determining whether self-sustainable and isolated non-anadromous populations exist.

Recovery potential

If the Canadian population is genetically related and ecologically exchangeable with other upper Columbia fish but is demographically isolated (Hypothesis 2), then the population could be considered endangered but with a high potential for recovery using U.S. hatchery stock augmentation. Recovery goals under Hypothesis 2 might include activities that reduce mortalities associated with spawning and rearing in Canada.

If the Canadian Chinook population originated from the U.S. is not isolated from U.S. upper Columbia fish (Hypothesis 3), it may be both genetically and ecologically exchangeable with U.S. fish and its productivity may in part be dependent upon U.S. strays. The observation of marked hatchery fish on the spawning grounds is evidence of straying, although straying rates are difficult to measure. All hatchery fish have been marked but a portion of the strays may also come from river spawned U.S. fish that are unmarked. If Hypothesis 3 is the basis of the recovery strategy then recovery goals could include large-scale hatchery augmentation from U.S. populations to increase the probability of recovery and accelerate the recovery time. A recovery strategy designed to maintain a demographically isolated and non-exchangeable population (Hypothesis 1) would need to consider the likely implications of hatchery augmentation of U.S. origin Chinook and the eventual extinction of an existing unique population.

A population viability model (PVA) was used to examine the potential of recovery for the Canadian Okanagan population (Appendix C; Davis et al. 2007). Data from the U.S. component of the upper Columbia Chinook salmon population was used as a surrogate in the model because data specific to the Canadian population is very limited. The PVA simulated the minimal adult spawning population size required to maintain a population until 2050 under a number of scenarios. These scenarios included an evaluation of present day (baseline) conditions, decreasing fishing mortality by 50%, halting fisheries, doubling juvenile survival, utilizing hatchery production, and combinations of these. In the simulation, hatchery augmentation varied from 50,000 smolts to 1.75 million smolts. The PVA did not consider augmentation from strays and assumed the good ocean survival in the recent historical record would prevail into the future. The model predicted that even in the absence of fishing, the Canadian Okanagan Chinook salmon population would be extirpated by 2050 without large-scale hatchery augmentation far in excess of what can be naturally produced from recent levels of spawner abundance.

Scope for Human Induced Mortality

Mortality Sources, Trends and Possible Causes

The following summarizes the sources of mortality and, where possible, estimates the mortality for each source imposed on the Chinook population.

Dams: Attempts to improve fish passage and reduce mortality at the U.S dams are ongoing endeavours. Adult and juvenile Chinook must survive the passage of nine dams and associated impoundments on their journey to and from the sea. Dams represent the greatest threat to the survival of upper Columbia River Chinook. An estimated 80-85% of the adult Chinook survive upstream migration, while only 43% of the juveniles survive the downstream passage.

Fisheries: The Okanagan Chinook destined to spawn in Canadian waters most likely migrate with other summer/fall, Upper Columbia River fish. These fish are harvested by ocean fisheries and by both tribal and non-tribal in-river fisheries. The main ocean fisheries include the Canadian west coast of Vancouver Island troll fishery, the Alaskan troll fishery, the southern U.S. troll fishery and the sports fisheries. Average fishing mortality from 1979 to 2004 was estimated to range from 48.6% to 74.2% and average mortality was 63.9%.

Introduced species: A total of 38 fish species currently reside within the Canadian portion of the Okanagan River, but only 24 are indigenous. Fourteen fish species (smallmouth bass, largemouth bass, yellow perch, pumpkinseed, bluegill, black crappie, carp, black bullhead, brown bullhead, brown trout, lake trout, brook trout, goldfish and tench), along with Eurasian water milfoil, and the freshwater shrimp *Mysis relicata* have been introduced. Many of these species are potential competitors or well known piscivores, consuming eggs, fry or juveniles. The foreshore of Osoyoos Lake is populated by yellow perch and this species may compete with rearing Chinook. Bass occupy Vaseaux Lake (upstream of McIntrye Dam), and their presence could diminish the possibility of extending the current range of Okanagan Chinook.

The dams on the Columbia River have impounded waters and created ideal conditions for both introduced and native piscivorous fish to prey on migrating salmon juveniles. Juvenile migrating Chinook must pass through these impoundments. The main predator is the northern pikeminnow. However, introduced fish species such as smallmouth bass, largemouth bass, channel catfish, and walleye each add an additional threat.

Hydro-modification and water quality: The stream channel has remained relatively unchanged over the past 50 years. There have been considerable improvements to sewage treatment, thus water quality has probably improved over the last 20 years. The major losses of spawning and likely rearing habitats have occurred in the Canadian Okanagan system as a result of channelization and dyking that occurred 50 years ago. Above the McIntrye dam, it was estimated that only 3 km of the historic 10 km of suitable channel habitat remains between Skaha and Okanagan Lake. The Canadian portion of the Okanagan River has been reduced by 24 km and has lost 88% of its riparian zone.

Water withdrawal: Water is withdrawn from both groundwater and surface water sources within the Okanagan basin and the demand for water appears to be increasing. The primary use is for irrigation with the highest demand from June to September. Peak discharge occurs in April and May. Approximately 90% of the streams in the Okanagan have been licensed at or beyond their capacity to yield water. If current human growth trends continue, it is possible that by 2020 the available water supply will be exceeded due to human demand. At present over 500 groundwater wells are located near the spawning areas in the Okanagan River. A decrease in aquifer water level will reduce the volume of water discharged into the river. The withdrawal of water ultimately results in loss of fish habitat.

Mitigation and Alternatives to Activities

Allowable harm

At the current high rate of mortality associated with the passage of Chinook through the U.S. system of dams, the recovery of a natural spawning population in the Canadian Okanagan River is improbable even if all fishing ceases. Based on the PVA, recovery is highly improbable without large-scale hatchery augmentation. Human activities that cause incidental mortality should be assessed in a risk management context given the large uncertainty in the data and future recovery conditions. Presently, there is little scope for incidental harm.

Alternatives to activities causing harm

There are no reasonable alternatives to eliminate the main activities causing harm in Canada. Habitat values within the Okanagan River have remained relatively unchanged for the last 50 years. Improvements to fish passage at U.S. dams have been made in recent years and may continue. No measures to reduce the impact of international fisheries on the Okanagan populations were considered.

Sources of uncertainty

Knowledge gaps in the life history of Okanagan Chinook have created considerable uncertainty in the assessment of factors affecting population recovery. We are unable to establish critical rearing habitats, estimate rearing capacity, or trends in rearing habitats. The international nature of the population limits options available to Canada for recovery. This is especially true in regards to mortality rates for migrating adult and juvenile fish, fishing exploitation rates, and hatchery augmentation. The role of groundwater in relation to habitat needs is uncertain as are future policies on water withdrawals. The interactions of Chinook fry and juveniles with non-native fish species (especially predation rates) are uncertain.

ADDITIONAL STAKEHOLDER PERSPECTIVES

The Okanagan Nation Alliance Fisheries Department in Westbank, B.C. is a major stakeholder with a specific mandate to conserve, protect, restore and enhance indigenous fisheries (anadromous and resident) and aquatic resources within Okanagan Nation Territory. The culture of the Okanagan peoples is closely linked with the animals they once used and therefore they have a vested interest in ensuring the survival of all salmonid stocks in the Okanagan Basin. First Nations once heavily fished Chinook at Okanagan Falls at the outlet of Skaha Lake.

There are traditional accounts of Chinook arriving in the river upstream of Osoyoos Lake in spring/early summer. There are two names for Okanagan Chinook used by aboriginal Okanagan peoples: Ntitiyix, meaning “king salmon”, and Sk’elwis, meaning “old king salmon”, which was used to refer to spawners later in the year.

CONCLUSIONS AND ADVICE

The efficacy of biologically-based recovery targets and strategies depend on the nature of the population being recovered. The weight of the genetic evidence, albeit based on small sample sizes, supports evidence that Okanagan Chinook are not demographically isolated nor are they genetically unique as a result of straying from neighbouring populations in the U.S.

The Population Viability Analysis indicates that because of the current low population abundance (<50 spawners), recovery of Okanagan Chinook is unlikely without large-scale hatchery intervention. Hatchery supplementation with U.S. fish will be required to off-set low spawning abundance and high dam mortality. This would compromise any remaining genetic uniqueness that may remain in the current Canadian population.

Research to resolve uncertainty in the nature of the Canadian population is a high priority for advising on recovery goals and strategies. To this end, future research activities include:

1) otolith ablation work to assess whether adult females sampled in the Okanagan system are offspring of non-anadromous females. This would help to further assess the plausibility of Hypothesis 1 – isolated demographically; and
2) assess the extent of immigration from U.S. natural and hatchery populations to test the hypothesis that the Canadian population is genetically exchangeable with U.S. populations.

There are a number of gaps in the understanding of basic life history characteristics for Okanagan Chinook. In particular, studies to assess the importance of juvenile rearing habitat for the survival or recovery of a Canadian population including the impact of invasive species should be undertaken as resources permit. Studies to assess the location and importance of groundwater are also important to improve the understanding of factors important for spawning success.

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FOR MORE INFORMATION

Contact: Tom Brown
Fisheries and Oceans Canada
Pacific Biological Station
Nanaimo, BC V0T 6N7
Tel: (250) 756-7091
Fax: (250) 756-7053
E-Mail: Tom.Brown@dfo-mpo.gc.ca

This report is available from the:

Regional Advisory Process (RAP) Office
Pacific Region
Fisheries and Oceans Canada
Pacific Biological Station
Nanaimo, BC V9T 6N7

Telephone:(250) 756-7208
Fax: (250) 756-7209
E-Mail: psarc@dfo-mpo.gc.ca
Internet address: www.dfo-mpo.gc.ca/csas

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